Software Based Network Optimization for a Large Manufacturer

By

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Submitted to the Engineering Systems Division
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Abstract

With expansion of commerce and boundaries of business, organizations have been working hard at improving processes and bills of material and have reached the bottom already. The focus is therefore, now shifting to the next logical area of optimization of supply chains. The ever-increasing competition is putting pressure on organizations to optimize their supply chains and many organizations are re-evaluating their existing supply chain networks. Often, as expected, they realize that it requires a complete overhauling. There may be too many suppliers or too many distribution centers, not quite optimally aligned in the chain. The important issue is not to impact customer service adversely, and yet, make the desired changes in the network.

A member company from the Affiliates Program at MIT's Center for Transportation Studies is one such company, looking at re-configuring their distribution system, questioning the need for multiple echelons in their distribution system. They are looking at reducing the number of Delivery Center locations and the possibility of doing away with the Central Distribution Centers where shipments from the plants are consolidated for shipment to the DCs. This study aims to address the following related issues:
What is the impact of reducing the number of DCs?
What would be the optimal location of a third DC assuming 2 DCs are known?
What would be the customer allocations in the new network with 3 DCs?
How would the assignments change if there was a capacity constraint posed on the DCs?

These issues were approached as a facility location problem with an objective function to meet the customer demand at the minimum cost. In a typical system, the constituents of this cost would be the transportation cost – Plant to DC to Customer, facility operating cost and the cost of carrying inventory at each DC. The number, location and size of the DCs relative to the plants and customer zones would be some of the decision variables that influence these costs.

The study was conducted by structuring the company data from the previous year into a model and using a mixed integer linear programming tool to arrive at the optimal solution. SAILS – ODS, a supply chain network optimization software, was used as the solver for the network model. For the purpose of this thesis, the analysis was limited to a study of the transportation costs as the driver for optimization.

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To Gitanjali & Anika

Acknowledgements

As I sit here, finishing up the thesis, I am reminded that its time to move on. This thesis is really the continuation of what I learnt at MIT over the past nine months. I wish to thank all my professors and friends who urged me forward in this learning process.

First, I would like to thank Prof. Jim Masters for supervising the progression of this thesis and encouraging me on.

I thank Tony Mirra of Insight for spending many hours with me on the phone, solving all the glitches I faced in running the models.

I would also like to thank all my fellow MLOGers who kept me company in 5-008 during all those late nights. It was fun.

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Chapter 1. Introduction

The problem of optimizing physical flows in networks has caught the attention of operations research specialists for many years. Customers have always demanded better service at lower costs, requiring logisticians to continually study ways and means to improve the efficiency of product movement from the manufacturing plants to the customers. Over time, many computer based algorithms and procedures have evolved to solve the network problem efficiently.

As these procedures evolved, it has become evident that network flow concepts could be used to address a rich variety of problems, even beyond the logisticians' concerns. This realization led to the development of many other applications such as personnel assignment, project scheduling, production planning and telephone call switching, to name a few.

1.1 Distribution Networks:

Design of the distribution network is a strategic decision that has a long-lasting effect on the firm. In particular, decisions regarding the number, location, and size of warehouses have an impact on the firm for at least the subsequent three to five years of operation.

The design of a distribution network involves many interdependent decisions which can be classified as facility, customer service, transport, and inventory decisions. All four of these areas are economically interrelated and should be planned collectively[1]. Location of a facility is often an important decision in the larger frame. Fig 1-1 shows some of the decisions required to be made for each of these strategic decision areas.

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[1] Ronald H.Ballou & James M.Masters, Commercial Software for locating warehouses and other facilities – Journal of Business Logistics, Vol.14, No.2, 1993.

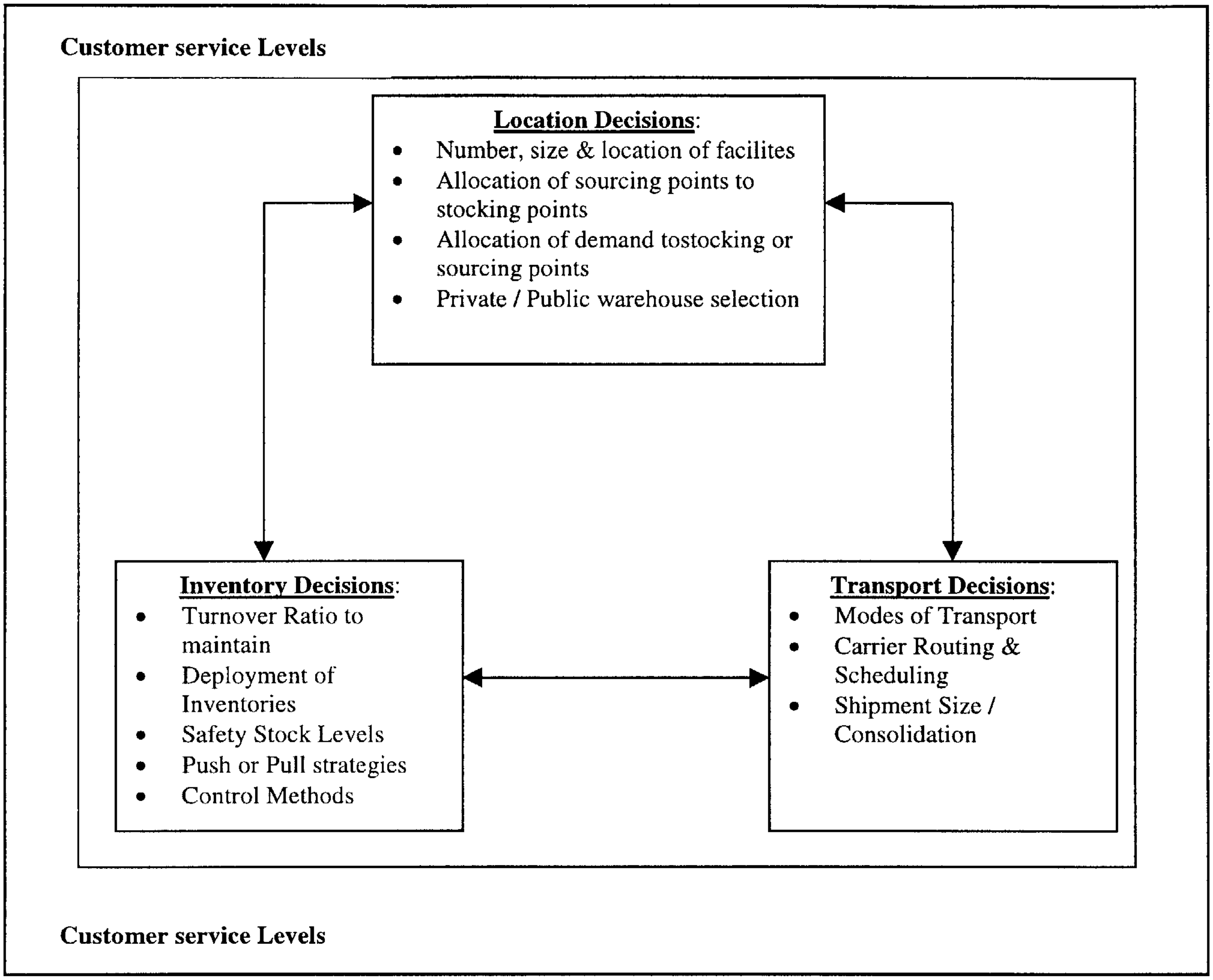

Figure 1-1 Four Major Strategic Planning Areas in Logistics System Design [1]

In addition to the interdependence between these four decision components, there is also interdependence between distribution network design and demand. The demand and its geographical distribution affect the optimal design of a distribution network, which in turn affects demand through its effect on customer service. Among the most important distribution network design decisions are those related to warehouse (DC) location.[2] Typically in the past, when network design optimization was not a popular phenomenon, the distribution network for a company evolved organically with demand. As the product reach spread farther, a new

[2] {Ho, Peng-Kuan, Univ of Maryland,1989; Warehouse location with service sensitive demand: AAD90-21511}

warehouse or distribution center was set up whenever the existing one ran out of space or the need was felt for one in new customer areas.

1.2 Why Locate Facilities Optimally?

If the location of the manufacturing plants (source) and the customers (demand) is considered fixed, the issue is to identify locations for the distribution centers or warehouses such that the cost of getting products from the plants to the customers is minimized. The main questions at this point, then become:

1. How many distribution centers?
2. Where to locate each of those distribution centers?

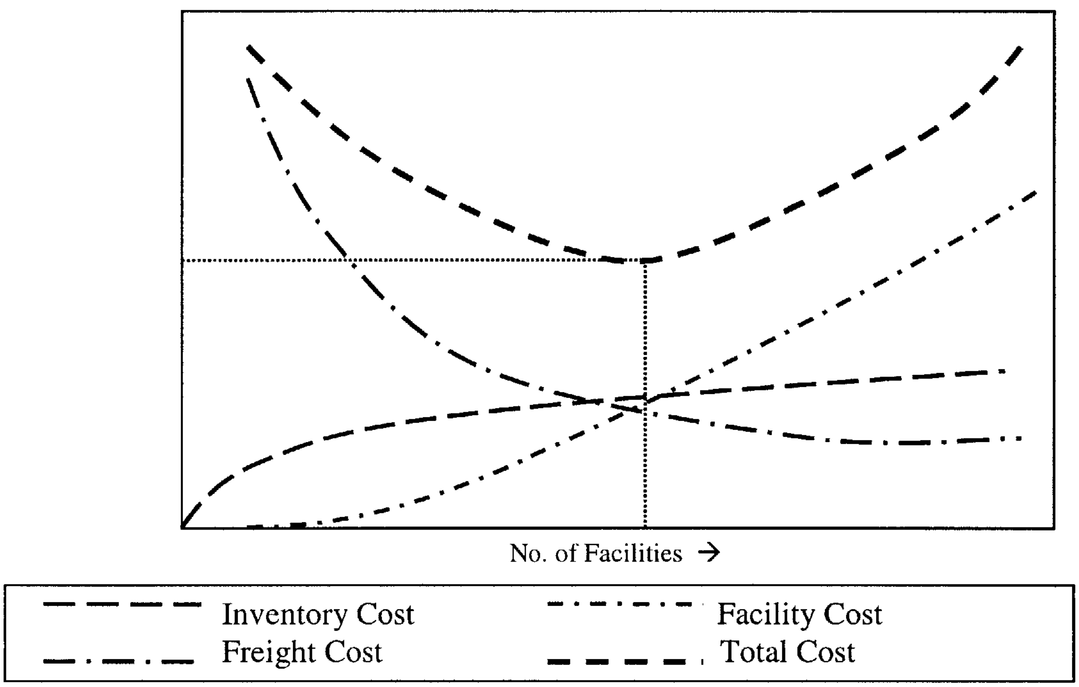

Figure 1-2 Interrelationship of Costs

As seen from the above figure 1-2, the freight costs in the system decrease as the number of facilities increases and, the facility costs increase. Also, as the number of DCs and hence the stocking points increase, the inventory in the system increases. With an increase in the number of DCs, it is possible to put products closer to the customers, reducing the distance to customer and hence the transportation costs. However, as the number of facilities increases, the total fixed costs also increase as more facilities means more buildings and related expenses. The total cost in the system is the summation of these individual costs and follows a "U" shaped curve. The lowest point on the curve is the minimum cost solution and hence the optimal number of DCs for the system.

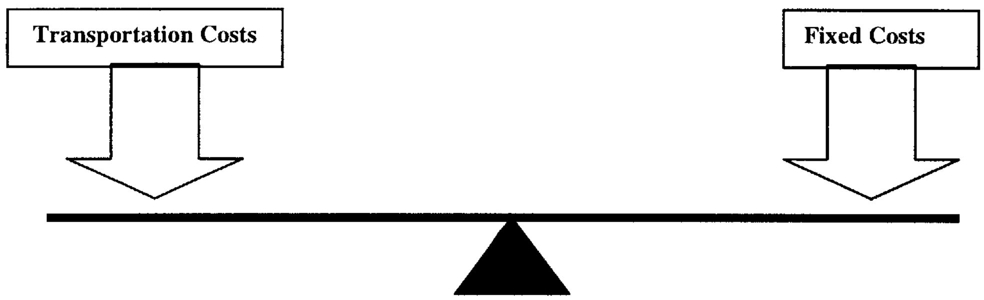

Figure 1-3 Transportation costs vs facility fixed costs trade-off

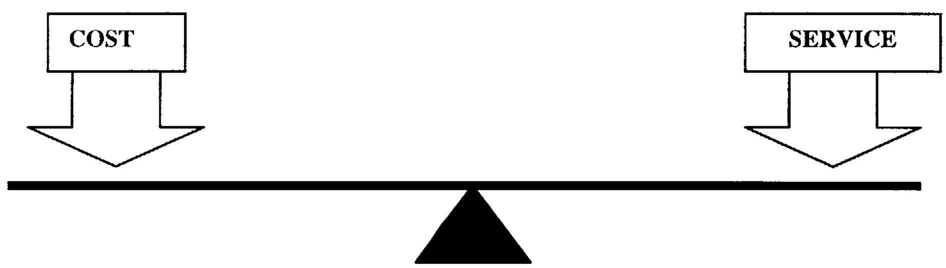

Figure 1-4 Cost Vs Service Trade-Off

The above trade-off must also be considered when deciding on the number of customer facing points. As goods move closer to customers, they typically have more value added so inventory becomes more expensive. Moreover, the firm loses flexibility to respond to changing demand since it loses its ability to turn its intermediate goods into different end products or product configurations. On the other hand, having goods closer to customers reduces lead times and provides better customer responsiveness. The tradeoffs are important to understand and model.

1.3 Motivation:

A member of the Affiliates Program at MIT's Center for Transportation Studies (CTS), wanted to investigate the benefits of rationalizing their current distribution system. They wanted to understand the means by which they could calculate the cost savings that could be realized from the rationalization.

This company manufactures finished products at seven plants located mostly in the north-eartern part of the country. There are 7 main product types, each product type being manufactured at only one plant. Some of the products have variants of the main product type. Additionally, there are 3 types of product that are outsourced. At the SKU level, there are approximately 4,000 different SKUs.

The company follows a two-echelon distribution system where the products flow from the manufacturing plants to four Central Distribution Centers (CDCs) where the goods are consolidated for shipment to seven customer facing Distribution Centers (DCs).

The products have widespread application from domestic household to industrial use, resulting in approximately 25,000 ship to points for the products. The main customers for the company are:

1. Consumer Products Stores like Superstores
2. Industrial / Commercial: (e.g. Independent Electrical Distributors)
3. Specialty: a) OEMs – manufacturers
   b) Other Manufacturers
   c) Export
   d) Specialty Products

The move towards rationalization was based on understanding of the fact that reducing the number of stoppage points in a system lowers the transportation cost of the system. Decreasing the number of stock points in a distribution system reduces the safety stock inventory held at each point. Based on the above two main issues, it was believed that decreasing the number of DCs from 7 to 3 and removing the middle echelon of the CDCs will reduce the total costs in the system.

This thesis highlights the differences that emerge from a mathematical solution to a real world situation and how the result are modified to give less than optimal solutions. The solutions thus obtained are "optimal" under the constraints and the model that was defined.

The thesis evaluates some of the different ways that the company could arrange their distribution network. If the network were being designed from zero-base, the range of design options would be entirely different. In a greenfield analysis, the solver may allow or shut any warehouse or transportation links. In reality however, as in the case of this study, there were issues of necessarily continuing with some of the existing facilities due to an existing circumstance like lease, labor or other similar issues. In this case, the location of 2 DCs was decided already and the location of the third DC was almost certain.

It was assumed that the plant locations will not change. The product mix was not changed and the demand pattern also remained the same. The objective was to design or reconfigure the logistics network so as to minimize the annual systemwide costs. This includes production and purchasing costs, inventory holding costs, facility costs and transportation costs. Facility costs arise from the fixed costs at the facility, storage and handling of products. These are likely to vary with location of the facility depending on real estate costs in the area, availability of labor, etc. (For the purpose of this study, these costs are assume to be constant over the selection of the location and hence ignored for calculations.) The transportation costs are also likely to vary with location of the facility depending on volume of total freight inbound to and out bound from the area where the facility is planned to be located. The selection of the mode of transportation is key to the cost. (In the model here, the transportation mode is assumed to be constant for a given customer, independent of the location of the DC that customer will be served from)

Chapter 2. Literature Survey

2.1. Network Optimization Methods

A network optimization analysis will typically provide an answer to the classic question: "Given demand for a set of products, either historical or forecast, what is the optimal configuration of the production or distribution network to satisfy that demand at specified service levels and at lowest cost?"[3] In the absence of a larger perspective on optimizing the entire supply chain, issue-specific local optimization is more prevalent in the industry as opposed to a system-wide or global optimization.

The common tools employed for network optimization are based on the mathematical techniques, the main techniques being:

1. Dynamic Simulation
2. Heuristics
3. Linear Programming

Modeling techniques are gaining popularity as decision support tools that companies use to analyze their supply chains. Simulation tools are popular, but more companies use optimization models to optimize some part of their chain. Experiences may vary across companies, but with careful and proper implementation, optimization techniques can provide solutions for means of improvement and substantial cost savings.

2.1.1. Dynamic Simulation Methods

[3] SAILS Concepts: A Handbook for SAILS Users.

Dynamic Simulation methods provide a detailed emulation of activities over time. In other words, such methods evaluate a modeled solution to the network design problem, rather than providing an optimal solution to the issues at hand. A simulation tool will not provide a recommendation to open or close any facilities in the network under consideration. It is difficult to create a model that can handle issues like fixed costs, capacity and economies of scale.

Sometimes, organizations may want to simulate the solution to a network design problem that has been obtained through optimization tools. This would be a good way to study the robustness of the obtained solution to withstand variations in the modeled parameters. Unfortunately, the software providers in this space have not developed this kind of an integrated tool in their offering that would enable a user to conduct sensitivity analysis on the modeling parameters without actually remodeling the entire network. To adapt the solution from the optimization solver to the simulation tool can be a very difficult and time-consuming task.

2.1.2. Heuristic Methods

Heuristic methods or common sense consideration of alternatives is not guaranteed to provide the optimal solution. The quality and optimality of the solution will depend on the quality of the decision rules considered. Heuristic algorithms take lesser time to solve as compared to optimization algorithms.

Optimization-based algorithms will either implicitly or explicitly sift through all possible choices, while even the most advanced heuristic procedure will investigate only a very small number that appear to be good. The heuristic guesses may or may not be good, but the important point is that there is no way to know for sure unless the true optimum is also established. If the true optimum is not known, the very real possibility exists for a better answer to be proposed externally by an analyst or manager.

A heuristic solver may miss important opportunities for cost savings. In all likelihood, a heuristic will identify some obvious savings; but less apparent sources of cost reduction, those often not identified by a heuristic procedure, can amount to many times the cost of the most extensive system design study.

A typical heuristics approach could be to assign customer demands to the least expensive node that is linked to the customer, then assign the resulting node to the least expensive to which it is connected, and so on, up to the level of source nodes. An optimization based solver finds the least expensive available flow path through the entire network (from the source to the customer) for a given demand. It does not optimize each level separately as that yields poor results..

A typical approach could be to draw circles around the Distribution Centers and serve all customers that lie within the circle. The radius of the circle would largely be dependent on the service limits set in terms of the maximum distance or time to customer as a company strategy. In such an approach, the customers that lie at the periphery of the circle or in the intersection zone between two circles may be randomly assigned to other closest Distribution Center. The approach does not consider the difference in cost that will factor in due to the changed movement of the product.

2.1.3. Mathematical Optimization Methods

Mathematical optimization techniques provide the capability to evaluate all possible alternative solutions to a given problem and arrive at a solution that is optimal within a specified tolerance range. The most important feature of mathematical optimization tools is that the solver either finds the true optimal (least cost) solution or at a minimum, finds a solution within a specified percentage (solution tolerance) of the optimum. With mixed integer linear programming models, the result obtained is within the specified tolerance percentage of the actual optimal solution. The range, of course, will be the decision of the management. It is important to remember that with a tighter tolerance, the complexity of the model and the run time will increase exponentially. This capability contrasts starkly with an approach like the heuristic based procedures, which can only guess at a better solution. They cannot establish whether the results are truly optimal.

2.1.4. Why Not Use a Spreadsheet?

Network design is a complex task involving large data sets. Spreadsheets are easy to use and widely understood, but network design requires the consideration of more combinations than a spreadsheet can effectively handle. For example, in a simple site-selection problem requiring the identification of 5 optimal warehouse locations from a set of 25 potential sites, 53,130 different combinations must be considered. This is far too many to analyze with a spreadsheet. The number of combinations grows exponentially as potential sites are added to the analysis.

A thorough network analysis solution should consider:

1. the optimal assignment of customers to distribution centers,
2. manufacturing capacity at the plants,
3. warehouse sizes and
4. complex transportation cost structures.

It is also helpful to have the ability to analyze different scenarios. By using spreadsheets, too much time will be spent crunching data and too many potential solutions will remain unexamined.

2.2. Mathematical Optimization Tools

The problem features dictate model formulations. A mixed integer-linear programming formulation is required whenever one wishes to deal with fixed costs, capacity constraints, economies of scale, cross-product limitations, and unique sourcing requirements.

A compelling reason for adopting optimization-based solver technology is also that only optimization permits reliable comparisons across runs on different model scenarios. If a heuristic solver is used, comparisons must be made among solutions whose direction and magnitude of error are unknown. Reliable run-to-run comparisons are essential if one wishes to explore uncertain formulation or data assumptions, evaluate alternative demand, supply, cost, service, or environmental forecasts, and establish the reasons why two different input data scenarios yield alternative solutions.

In sum, optimization results in fewer runs, superior analysis, better solutions, increased savings, and less risk.

The models in an optimization tool and the associated solvers are of the Mixed Integer Linear Program type. They are mixed because they handle and provide solutions to both integer and non-integer types of decision variables:

- Mixed Variables (Also called as the Flow Variables): the quantity of a product that flows between two nodes (or on a transportation link), the quantity of product procured or manufactured at a facility.
- Integer Variables: (Also called as the Structural Variables) Decision to open or close a production plant, assign jobs to a production line, select suppliers for a product, assignment of customers to a facility.

The algebraic equations used to specify the underlying mathematical relationships are straight line functions in the solver. This makes it a Mixed Integer LINEAR Program. Non linear relationships such as those that define economies of scale are modeled as piece-wise linear functions to maintain the linear nature of the model to keep it solvable.

2.3 Analysis of mathematical models:

Although modeling tools generally address customer service, inventories and transport selection, treatment is usually at an aggregate level. The fine problem definition and decision making details that are required in the practical world are left lacking due to aggregation[4].

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[4] Ronald H.Ballou & James M.Masters, Commercial Software for locating warehouses and other facilities – Journal of Business Logistics, Vol.14, No.2, 1993.

A mathematical model will consider the costs associated with the complete movement from the manufacturing plan - to the distribution Center - to the customer zone for each product that goes into the customer zone. Thus it may happen in a mathematical solution that two neighboring customers are assigned to two different distribution centers on the basis of freight costs that arise from the different product-freight combinations that customers frequently demand. The organization will need to be clear on its strategy on the trade off between cost and service. Serving different customer-product-mode combinations from different locations may be more cost effective as against enforcing that a customer be served all products, irrespective of mode from the same location, even though that would provide better customer service.

2.4 An Operations Research perspective of the Model:

2.4.1. Problem Formulation:

From an Operation Research perspective, this is a combination of an assignment problem and a facility location problem. One problem might be to assign customers to a warehouse so as to meet their demands. In such a case, the warehouses are the sources, the customers are the destinations, and the costs represent the per unit transportation costs.

2.4.1.1. Objective Function:

Minimize $\sum_i \sum_j \sum_l X_{ijl} C1_{ijl} + \sum_j \sum_k \sum_l Y_{jkl} C2_{jkl} + \sum_j Z_j CF_j$

Inbound Costs	Outbound Costs	Facility Costs

2.4.1.2. Decision Variables:

X_{ijl} : Quantity of product l flowing from Plant i to DC j

Y_{jkl} : Quantity of product l flowing from DC j to Customer k

Z_j : binary variable = 1 if facility j is open, else 0

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w_{jk} : Binary variable = 1 if customer k assigned to DC j, else 0

2.4.1.3. Parameters:

$C1_{ijl}$: Cost of transporting one unit of product l from Plant i to DC j

$C2_{jkl}$: Cost of transporting one unit of product p from DC j to Customer k

CF_j : Cost of operating Facility j

d_{kl} : Demand for product l at customer k

m_j : Capacity at DC j

2.4.1.4. Subject to Constraints:

1. All customer demand must be met :

$\sum_j Y_{jkl} \geq d_{kl}$ for each k and l

2. For outflow, there must be at least that much inflow:

$\sum_i X_{ijl} \geq \sum_k Y_{jkl}$ for each j and each l

3. If material facility flows out of a DC, it must be open:

$\sum_k \sum_l Y_{jkl} \leq Z_j m_j$ for each j

4. Number of DCs to be open is fixed

$\sum_j Z_j = n$ { n = desired number of DCs}

5. Bundling of products (restraining one customer to be assigned to only one DC for all products):

$\sum_l Y_{jkl} \leq w_{jk} \times B$ for each j and k {B is a large number)

$\sum_j w_{jk} \leq 1$ for all k

In the absence of facility data, it may be tempting to ignore the facility costs in the equation. Since the solver seeks a minimum cost solution, it will assign demands to facilities that minimize the transportation costs only. It does not recognize the constraint on the number of facilities to be opened as there is no extra cost attached for opening more facilities. It is essential to assign each facility at least a notional cost so that the solver does not seek a solution where more than the desired number of facilities is open.

The above objective function is formulated for capacitated facilities with a capacity limitation m_j. In reality, a warehouse or DC will have a limit on the annual throughput it can deal with. There will be a limit on the maximum quantity of goods that can be stocked at a given time due to space limitations.

The above set of constraints may give solutions where the capacity constraint is ignored and assignment of customer demands exceeds the capacity. This issue can be addressed by imposing a penalty on any excess throughput at the facility beyond the limit set on capacity. Since the solver seeks a minimum cost solution, any solution with a penalty is likely to be less optimal and hence such a solution will be discarded. It is then very important to select a good value for the penalty. Typically, if there is an option to lease additional space, the cost of leasing the facility may represent the penalty introduced here. The solver will look at this problem as two facilities with different costs, the more expensive facility (the additional space leased) to be chosen only once the less expensive facility (the original DC) has been filled to capacity. Customers will be assigned to this additional facility if the cost of assigning them here is lower than assigning them to another facility. If this is not an option, the solver must be prevented from assigning any demand greater than the capacity to that facility. This may be achieved by assigning a high value to the penalty cost. Adding a penalty clause to the problem formulation results in the addition of more integer variables, making the problem tougher to solve.

2.5 Insight SAILS

2.5.1. Introduction to SAILS:

Insight: It is truly a global optimization model. The system recommends a combined vendor, production and distribution network that minimizes cost or weighted cumulative production and distribution times, subject to meeting estimated demand and restrictions on local content, offset trade, and joint capacity for multiple products, echelons, and time periods.[5]

The SAILS solvers are computer based procedures designed to find the best possible strategic logistics network design from among several possible alternatives, best meaning least cost, possibly subject to managerially imposed restrictions and constraints.

SAILS is a product of ongoing R & D efforts in large-scale optimization at INSIGHT Inc., a supplier of logistics management support systems. Coupled with INSIGHT's logistics data management modules and graphic user interfaces, SAILS is a capable logistics management support system.

As the logistics management community has become more sophisticated in the use of modeling systems, the logistics systems themselves have become more complex, giving rise to the need for more modeling power. In addition to the classical distribution network issues, new questions are being raised about raw materials options, the scheduling of multi-stage manufacturing operations, and the best use of multi-capability production facilities. SAILS addresses these and the other following complex logistics management issues.

2.5.1.1. Network Rationalization Issues

1. Assignments of customers to distribution centers (DCs)
2. Number and locations of DCs
3. Mission of each DC - inventories and service territory
4. Assignments of DCs to plants by product
5. Number and locations of plants
6. Mission of each plant - production by product, inventories, and service territory.

2.5.1.2. "What If " Questions

1. Business decision and policy issues

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[5] Supply Chain Optimization – Keely L. Croxton, Thomas L. Magnanti, MIT (Jan, 1996)

Plant capacity expansion

New product introduction

Shipment planning policy analysis

DC capacity expansion or elimination

Multi-division distribution system merger.

2.5.1.3. Sensitivity Issues

1. Distribution cost vs. customer service
2. Distribution cost as function of number of DCs
3. Demand forecasts.

2.5.2. Description of SAILS[6]

SAILS consists of user-friendly graphical interfaces, a data management system for model generation, and INSIGHT's proprietary optimizing solver. SAILS is a logistics network modeling tool that can be used for simple models where the data are entered by the user through a graphical user interface as well as for complex models where the data may exist in the form of millions of shipment transactions. The data management features of SAILS permit the user to choose the level of model complexity. A great deal of data generation can be handled automatically such as customer zone definition and freight rate generation.

Once a modeling database has been created, the scenario generation features of SAILS facilitate rapid generation and evaluation of many alternate scenarios for analysis. There are also numerous shipment planning controls which permit the user to evaluate the network impact of various shipment planning options such as pooling, stop-offs, pickups, and direct plant shipments.

When a given scenario has been generated, the optimizing solver selects from among the billions of alternative structures and flows, that one network design which minimizes total cost for that

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[6] SAILS Concepts: A Handbook for SAILS Users, Volumes 1 & 2 (Users Guide)

scenario. The solver is a mixed integer linear program that uses an advanced technique called network factorization to achieve solution speed for large problems.

2.5.3. Modeling using SAILS ODS

2.5.3.1. The inputs to SAILS

- Customer demand - can be forecast or last year's historical shipments in either transaction form or in some more highly aggregated form
- Aggregated product and customer identification
- Facility data for plants and DCs - includes processing rates, costs, and capacities as well as location
- Transportation options and rates for plant to DC, DC to DC, and DC to customer shipments
- Various policy considerations such as shipment planning rules, customer service requirements, and DC inventory restrictions.

2.5.3.2. The outputs from SAILS

for each scenario generated and optimized include:

Manufacturing

- Which plant should produce which products and in what quantities
- Which distribution centers should be served by each plant.

Distribution Centers

- Which distribution centers should be open and which should be closed
- Which products should be carried in each distribution center
- Which customers should be supplied from each distribution center, given customer service objectives.

Customer Support Patterns

- Map display of customer service area for each distribution center

- Graphical display of number of customers served by distance intervals from distribution centers.

Financial Information
- Total production/distribution system cost
- Transportation cost -- Plants to distribution centers; Distribution centers to customers
- Warehousing and inventory cost (fixed and variable)
- Production cost.

SAILS provides many valuable facilities for dealing with the typically large files of logistics data. The model generator performs all of the tasks commonly associated with the "matrix generator" front end of conventional optimization systems, and also many of the tasks commonly associated with a data base management system.

SAILS is a demand driven model. The aggregate commodity flows in the network are induced exclusively in response to customer demands. Flow on a particular arc may occur either because of favorable economics or capacity limits that must be satisfied. Either way, decisions made by a demand driven model are influenced strongly by product volume. In other words, products with high demands will influence the final solution far more than lightly demanded commodities.

2.5.4. The SAILS Solvers

SAILS consists of 2 solver models that can be used to define and solve a network optimization situation:

1. SAILS ODS
2. SAILS Optima

2.5.4.1. SAILS ODS

The Optimizer for Distribution Systems (ODS) is a 3-echelon model that can be used to design a straightforward finished goods production / distribution logistics network like the one planned. It can model Plants, Distribution Centers and Customer Regions as the network location nodes. The corresponding links that are modeled are Replenishment (from Plant to DC) and Outbound (From DC to Customer Region).

2.5.4.2. SAILS Optima

The other solver in the SAILS, Optima, can represent multiple stages of a manufacturing process inside a given plant location, using multiple discrete production lines per stage. It can be used to model networks ranging from finished goods production / distribution to fully integrate supply chain systems. Optima can be used to model a complete supply chain from source of raw materials to finished product customers with any number of echelons.

Due to its complexity, Optima typically requires more human and computer resources for master database preparation and manipulation than does a typical ODS model. For this reason, the ODS was chosen as the solver for this study.

Chapter 3.: Model Data and Network Definition

The objective of this thesis was to examine the various courses of action that the company could follow in their attempts to redesign their distribution network. This chapter describes the data used in the model to define the network.

3.1. Description of the optimization model

3.1.1. The Objective of the Model is to minimize the sum of:

1. Transportation Costs

- Replenishment (from Plant to DC)
- Outbound (From DC to Customer Region)

2. Facility Costs

- Distribution Center
- fixed costs
- variable costs
- Penalties for violation of capacity constraints

3.1.2. The Decision Variables for the model to solve are:

1. Network Flow

- the amount of each finished product that flows through each DC location
- the amount of each finished product that flows on each Replenishment link
- the amount of each finished product that flows on each Outbound link

2. Structural

- Open / Close decision for each DC location
- Single DC assignment for each customer region X customer class X product bundle

3.1.3. The Constraints to be defined for the model (limits on the decision variables) are:

1. Network Flow:

- All customer demand must be satisfied
- Total demand for each finished product is equal to total quantity manufactured.
- Total quantity of each finished product shipped from a DC location is equal to total quantity of the given product shipped to the given DC.

  (Mass Balance Equations – Inflow = Outflow to be followed for each DC)
- Total quantity of each finished product shipped from a Plant location is equal to total quantity of the given product manufactured as the given Plant. (Mass Balance Equations – Inflow = Outflow to be followed for each plant)

2. Structural:

- each customer region – customer class – product bundle is assigned to exactly one DC location.

3. Facility: (these constraints are optional):

- Capacity limits on production – arising from machine or process capacities
- Capacity limits on throughput at DCs – arising out of space limitations

3.2 Data Sources

The data used in the analysis in this thesis was based on the company's actual transaction data from the previous year. The basic data sets provided by the company were:

1. Existing Situation:

- Location of plants, CDCs, DCs – by 5 digit zip codes
- Location of Customers – by 3 digit zip codes
- Product-plant relationship – what product is made where
- Product flow quantities –

  - Plant to CDC
  - CDC to DC
- DC to customer – by product, by mode

2. Plans for the Future:

- Location of DCs: How many, what locations locked open and what locations are probable candidates
- Likely Number of DCs

The data was provided in the form of Microsoft Excel sheets and was adapted to the specified formats as required by SAILS ODS.

3.3 The Model

3.3.1. The Existing Network:

Products (4,000 SKUs) are manufactured at 10 geographically dispersed plants. Shipments from these plants are consolidated at 4 Central Distribution Centers which are used as replenishment points for the 7 distribution centers. The present customer base comprises of approximately 25,000 geographically dispersed ship-to points.

3.3.2. The Planned Network:

The future plan is to move from a 3-echelon network to a 2-echelon network. In this network, the middle level CDCs are eliminated and products are shipped direct to DCs from the manufacturing plants. Also, in the new network, the number of DCs is reduced to 3 from 7.

3.3.3. Products:

The range of products made and sold is approximately 4,000 SKUs. However, to simplify the data for the model, 15 product families are considered, each made at only one plant. It is assumed that each product has similar characteristics in terms of product density, packaging, etc.

3.3.4. Transportation

The actual freight movement occurred by 5 modes –

- Truckload (FTL)
- Less Than Truckload (LTL)
- Package
- Expedited
- Pickup

For the purposes of modeling, the above modes were considered at the following rates:

FTL, LTL, Pickup : @ Yellow 500, 1999 rates with a discount of 75%

Package, Expedited : @ UPS Ground, 1999 rates

The built-in library of rates in SAILS was used for the model.

The number of plants modeled was 10 as opposed to the 7 physical plants that the company actually has. This was done to accommodate the outsourced products in the system flows. **Table 3-1** as given below, summarizes the plants and the products that are made there.

Sl #	Manufacturing Plant Location	Product No.
1	Drummondville, Quebec (Canada)	103
2	Manchester, NH	105, 106, 107
3	Maybrook, NY	102
4	St.Marys, PA	100
5	Versailles, KY	103
6	Winchester, KY	101, 121,122
7	Juarez, Mexico	101
8	Elk Grove Village, IL	112, 114 (Outsourced)
9	Eastern Factory Warehouse	104 (Outsourced)
10	Western Factory Warehouse	130 (Outsourced)

Table 3-1: Manufacturing Plants and Products

With the above information, the total customer demand was mapped back to the manufacturing plants to yield a table of outflows from each of the plants.

3.3.5. Data Collection and Aggregation:

A typical network optimization problem requires overwhelmingly large amounts of data collection. For the purpose of this study, data was collected as per the scope of study defined and aggregated so as to have minimal impact on the results, yet simplify the model to manageable proportions.

Aggregation may result in loss of some information and so it is always an issue on how much to aggregate. There are two main reasons for aggregating data:

- The first is that the original data will result in a large model that may be difficult to handle and may take a very long time to solve. The time taken to solve the problem grows exponentially with the number of customers in more complex models.
- The second reason is that aggregation of demand data improves the accuracy of the forecast demand. The ability to forecast demand at an aggregate product and customer level is much better than that to forecast at the individual customer – product level.

1. Location of customers, plants, existing and proposed warehouses.
2. Customer Demand: The 25,000 customer ship-to points were aggregated to 915 3-digit zip code locations. A single customer located at the center of that zip code area represented all customers within the area defined by a 3-digit zip code.
3. Products: In order to aggregate the 4,000 SKUs, they were aggregated into product groups, based on the similarity in distribution pattern and product type. In this case, the products were essentially variations in the models and style and differed in type of packing (as in 6-pack vs 8 pack). This enabled the aggregation of products into 15 types, with each type made at only one plant.
4. Annual demand for each product by customer location. Ideally, considering the fact that the location decision will impact the firm for the next few years, future changes in customer demand should be taken into consideration while designing the network.
5. Transportation rates by mode. The SAILS software has built-in rates for Yellow-500 and UPS with a provision to scale these as required. These rates were used to project the costs for the future network.

6. Shipment Profiling: The flows in the model are cost on the basis of the Shipment sizes and mode. The profile into or from a node was based on the how much material passed through the node, in how many shipments and by what mode. The shipments into / from each node were averaged for each mode to give a profile for the shipments. It was assumed that the shipment profile would not change for change in configuration of the network.
7. Warehousing and facility costs – fixed, labor, inventory carrying, etc. These were assumed independent of location and hence ignored for the study.
8. Order processing costs were also considered invariable and hence ignored.

3.3.6. The Design Questions and Description of the models developed:

A series of models were developed and run on the software to study the various issues involved in the network optimization. This section provides a description of the models that were developed to answer the questions posed:

Q.1. What would be the customer allocations scenario if there were to be 3DCs in the network –

(i) Bethlehem, PA

(ii) Ontario, CA

(iii) Versailles, KY

OSNEW3: This model mapped the existing customer demand at 915 3 digit zip codes to the 3 DCs.

Q.2. How do the costs in the new system compare with the existing system?

OS7FTL: Mapped the existing customer demand as flows from the plants to customers through the 7 DCs. Modeling the network including 4 CDCs was beyond the scope of this thesis and these were omitted. The products in this model flowed from the plants to the DCs as truckload.

OS7OLD: This model was developed as a variation with the shipment profile from plants resembling what the company expected it to be for a 3 DC model.

Both these models were used to compare costs between the 3 DC and 7 DC scenarios.

Q.3. If it were possible to select the location for a third DC, assuming that Bethlehem, PA and Ontario, CA were locked open, what would that be?

OSNEW1: It was defined to this model that the required number of DCs was 3, out of which, 2 DCs - Bethlehem, PA and Ontario, CA were locked open. The solver would select the optimal location from 8 other locations identified.

Q.4. What if there is a capacity constraint on the DCs?
How will the customer assignments and the costs in the system change? Would the location of the third DC change?

OS3NCAP8: This model was adapted from the OSNEW1 model with addition of a constraint on the maximum capacity or throughput permitted on a DC. This capacity was constrained at 150 Million pounds. A penalty of $1,000 / CWT was imposed for violating the capacity.

OS3NCAP5: This model was also adapted from the OSNEW1 model and the capacity was constrained at 100 Million pounds. A penalty of $1,000 / CWT was imposed for violating the capacity.

OS3NCAPBI: This model was adapted from the OS3NCAP8 model with increase in the capacity violation penalty to $100,000 / CWT.

The lower capacity violation penalty represented a case where it could be possible to expand capacity by leasing extra space. The higher penalty represented the situation where the capacity could not be expanded.

Q.5. How do we know that 3 is the correct number? Should it be 4? Or 5?

OSNEW4: This model was adapted from the OSNEW1 model. With the same set of choices for location for the new DCs, the model was constrained to seek optimal locations for 4 DCs.

OSNEW5: This model was also adapted from the OSNEW1 model, with a constraint for the model to choose 5 optimal locations.

Chapter 4.: Results and Conclusions:

The objective of this thesis was to analyze some of the issues that the company was faced with as they proceeded to change the configuration of their distribution network. The problem identification, data and network modeling aspects were discussed in the preceding chapters. This section focuses on a discussion and analysis of the results obtained through different scenario runs of the model. Some of the main concerns critical to the design of the network were defined in chapter 3. This chapter answers those questions on the basis of an analysis of the results obtained.

4.1. What would be the customer assignments if there were to be DCs at 3 predetermined locations in the network?

<u>OSNEW3</u>

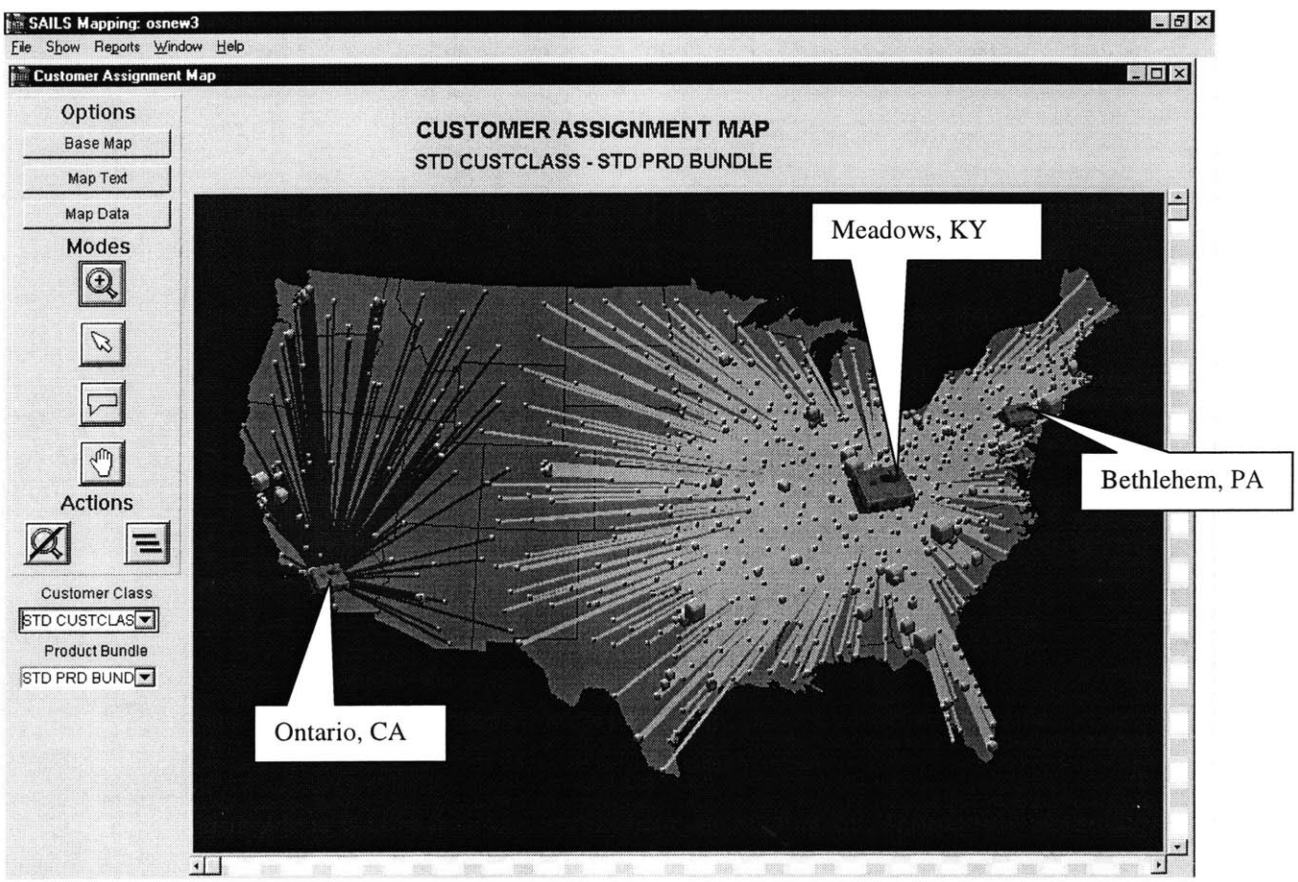


Figure 4-1: Customer Assignment map for 3 predetermined locations

The above customer assignment map shows that the Kentucky facility will be the largest of the three facilities in the 3 DC network. The facility handles the largest volume of the 3 DCs. A detailed text description of the customer assignments generated by SAILS is given at **Appendix.1.**

Customer service Histograms showing the portion of assigned demand covered by each of the DCs are given in **Appendix.2.** Bethlehem, PA has a small service area, meeting all its assigned demand within a radius of 250 miles. Meadows has more densely spread demand upto 1,500 miles. Ontario, on the other hand, serves a lower demand upto 1,500miles, but with most of it being served within 500 miles.

The system costs for this 3 DC model are compared with the 7 DC model in **Table 4-1**. Also, **Table 4-2** gives a comparison between the costs and activities at the various locations under the 7 DC versus the 3 DC situation.

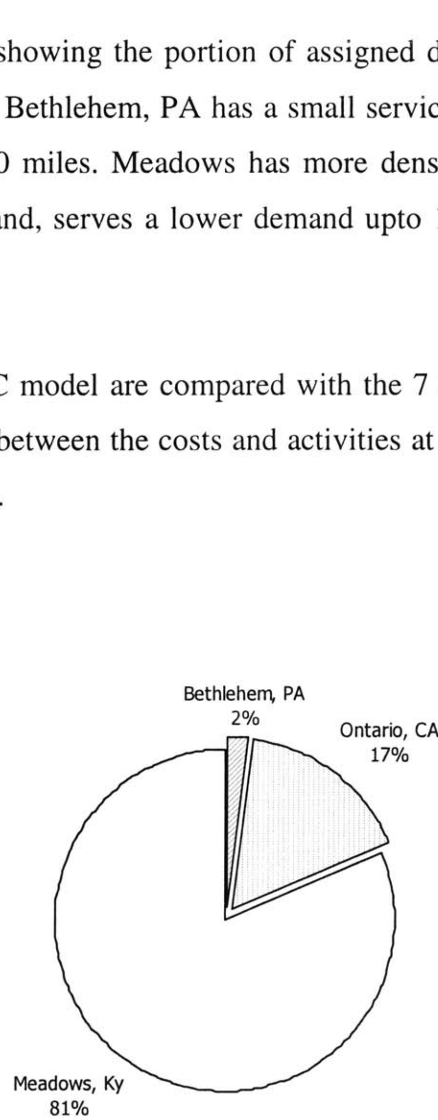


Figure 4-2 Share of demand served by each DC in a 3 DC network

4.2. How do the costs in the new system compare with the existing system?

<u>**OS7FTL:**</u>

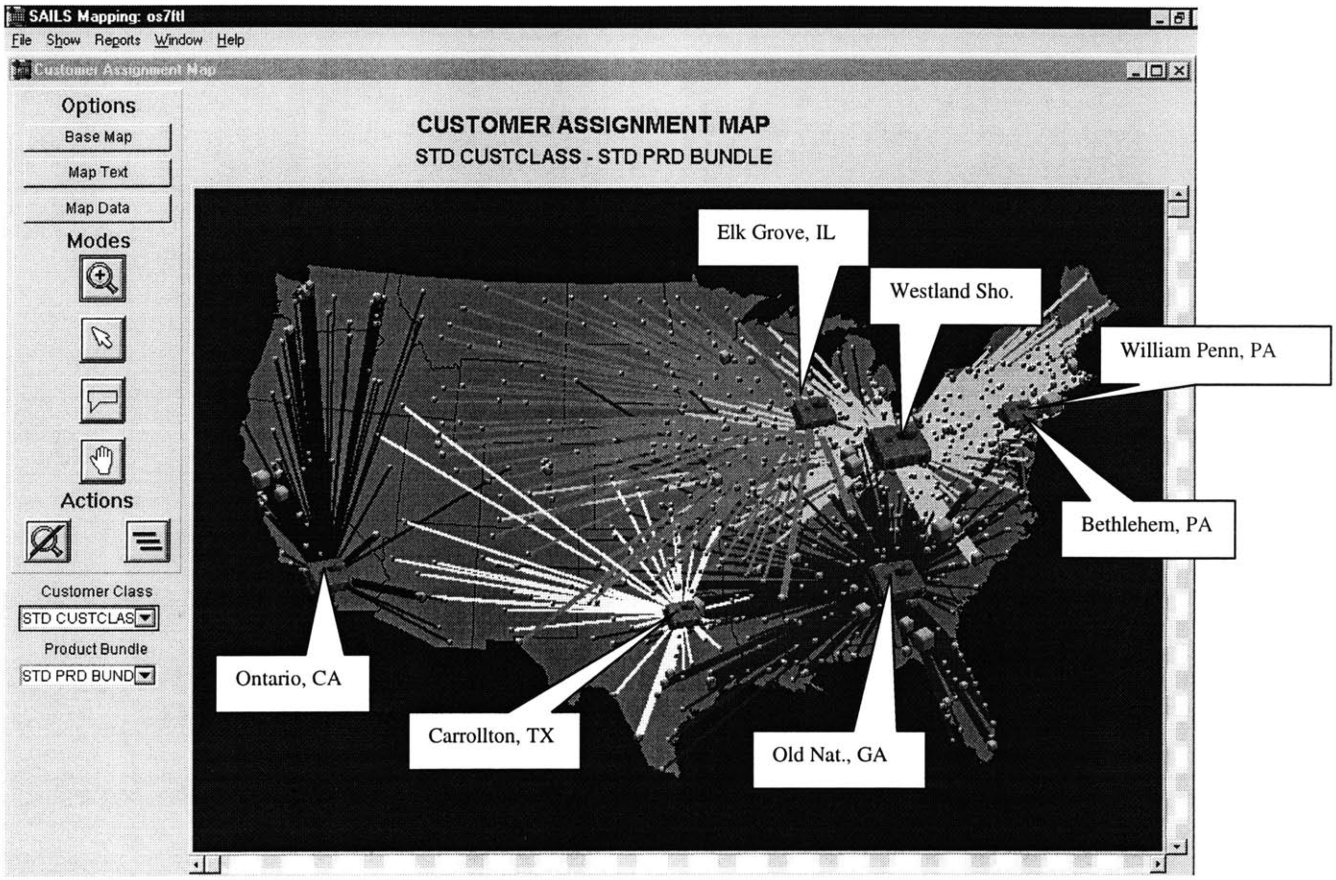


Figure 4-3: Customer Assignment map for the existing 7 DC network

The above customer assignment map indicates that the Carrollton, TX, Bethlehem, PA and the William Penn., PA DCs have fewer customer assignments compared to the others. In fact, the detailed text report indicates that the William Penn., PA DC has no customer assignment whatsoever. All the demand is assigned to the Bethlehem, PA DC as that happens to be co-located with a manufacturing facility. The solver provides a mathematical optimal solution. It indicates that only one of the two - William Penn or Bethlehem may be assigned any customers in an optimal network. The two are located so close that the solver eliminates one altogether, thereby saving on the total facility costs. Locations that are closely located enjoy essentially the same access to available demand, share virtually identical freight rates and usually exhibit similar cost structures. Hence these cannot be meaningfully differentiated for location decisions. Factors like existing facilities, interstate highway access, rail siding, dock access, EPA regulations, soil conditions, tax laws and other such matters should ideally be considered before the actual modeling. Such issues are beyond the scope of this mathematical model.

OS7OLD:

The company believed that in switching to a direct-to-DC network, many shipments from the plants would become LTL shipments as against the existing truckload shipments from the plants. By eliminating the CDCs, the advantage gained through consolidating shipments to truckloads is lost and this results in an increase in the total costs of the system. In this case, the inbound to DC costs increase because the LTL mode is more costly than the full truckload. There was no substantial change in the outbound costs from the DC to the customers as the profile there was not changing.

Details of the comparison between costs in the three models is given in **Table 4-1**.

	OS7FTL	**OS7Old**	**OSNEW3**
	7 Existing @ FTL	**7 Existing @ LTL**	**Planned 3**
System-wide			
Volume Flow (CWT)	2,233,706	2,233,706	2,233,706
Replenishment Cost	$ 25,554,000	$ 26,899,000	$ 23,729,000
Outbound Cost	$ 23,440,000	$ 23,400,000	$ 25,346,000
Facility Costs @1,000 / Facility	$ 6,000	$ 6,000	$ 3,000
Penalty Costs			
Total Cost	$ 49,000,000	$ 50,305,000	$ 49,078,000
Overall Demand Wt Avg	394.02	384.23	543.45
Avg Cost / CWT	21.937	22.521	21.972

Table 4-1: Comparison of system costs between the Old & New DCs

By changing to a 3 DC network from 7 DCs, the distance to customers is increasing. Table 4-1 indicates that the outbound demand weighted distance for the 3 DC network increases to 543.45 miles from 394.02 in the 7 DC network. This would indicate the possibility of longer lead times and hence reduction in service levels. The outbound costs thus increased substantially as in the new scenario, the demand is being met from a larger weighted average distance.

	OS7FTL	**OS7Old**	**OSNEW3**
	7 Existing @ FTL	**7 Existing @ LTL**	**Planned 3**
Bethlehem Flow	82,361	64,261	41,974
Cost in	1,110	913	641
Cost Out	814	707	506
Total Cost (1000$)	1,924	1,620	1,147
Overall Demand Wt Avg	75.36	82.08	93.41
Ontario Flow	346,552	346,487	374,577
Cost in	6,140	6,426	6,980
Cost Out	3,319	3,318	3,754
Total Cost	9,459	9,744	10,734
Overall Demand Wt Avg	439.32	439.32	460.62
Meadows Ky - Flow			1,817,155
Cost in			16,107
Cost Out			21,086
Total Cost			37,193
Overall Demand Wt Avg			570.92
Old National GA	612,090	542,632	
Cost in	6,625	6,090	
Cost Out	5,798	5,123	
Total Cost	12,423	11,213	
Overall Demand Wt Avg	395.11	354.57	

Elk Grove Flow	277,429	288,367	
Cost in	972	3,257	
Cost Out	3,555	3,713	
Total Cost	4,527	6,970	
Overall Demand Wt Avg	459.55	478.03	
Carrollton TX Flow	118,646	154,130	
Cost in	1,518	2,156	
Cost Out	954	1,109	
Total Cost	2,472	3,265	
Overall Demand Wt Avg	218.18	175.78	
Westland Shoppoh Flow	796,628	837,829	
Cost in	7,188	8,057	
Cost Out	9,000	9,431	
Total Cost	16,188	17,488	
Overall Demand Wt Avg	409.78	409.89	
William Penn Flow	-	-	
Cost in	-	-	
Cost Out	-	-	
Total Cost	-	-	
Overall Demand Wt Avg			
Indianapolis, IN	82,361	64,261	
Cost in	1,110	913	
Cost Out	814	707	
Total Cost	1,924	1,620	
Overall Demand Wt Avg	75.36	82.08	

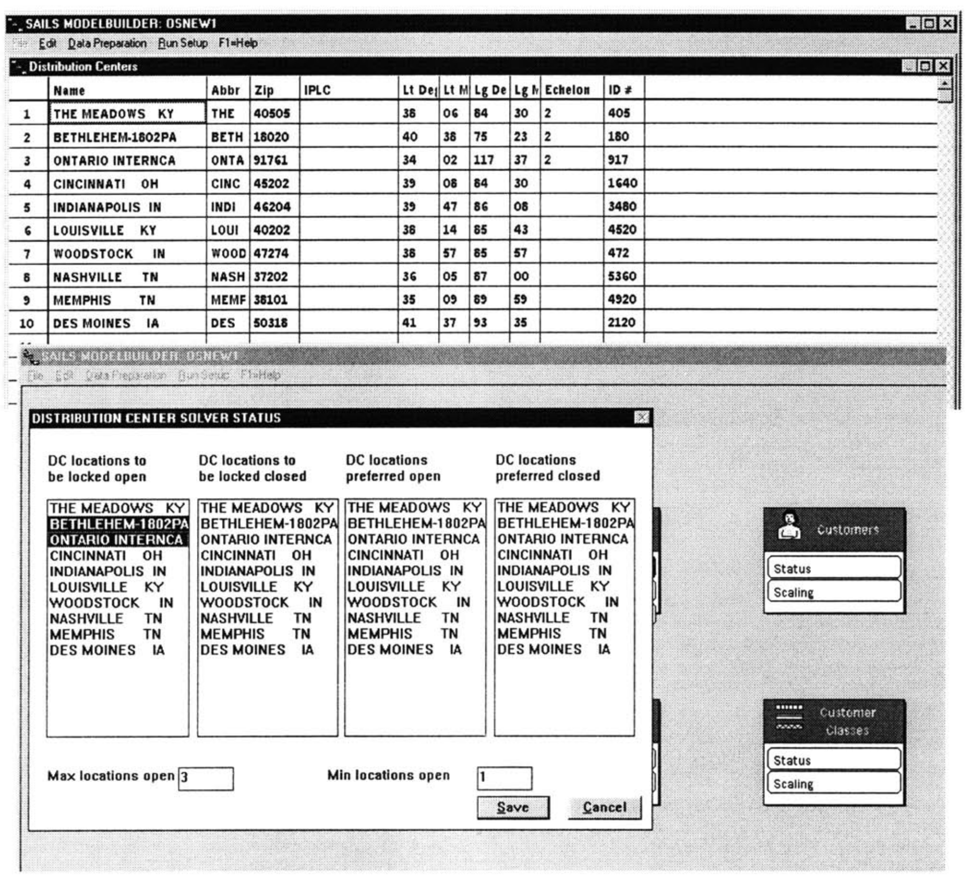
Table 4-2 Comparison of Costs at DC level between Old and New Networks

The shift from 7 DC network to 3 DC network also indicates an increase in the weighted average distance for each of the DCs. Even the 2 existing DCs will serve customers at an increased weighted average distance. Customer Service histograms showing the assignment of demand to each of the 7 DCs are given in appendix-3.

4.3. If it were possible to select the location for a third DC, assuming that Bethlehem, PA and Ontario, CA were locked open, what would that be?

<u>OSNEW1:</u>

During its growth phase, a company would have purchased land at various locations as an investment for future use. Land does not depreciate and can be used to build another plant or even storage facilities. In this case, the company had a stretch of land at Meadows, KY and was looking at the optimality of setting up a DC there in the new network under consideration. It was already decided that the DCs at Bethlehem, PA and Ontario, CA would definitely remain open in the new network. The question that remained was to explore whether Meadows was an optimal location. To address this issue, a model was created with 10 possible locations from which the solver was required to select 3 locations that were optimal from the perspective of a supply chain network optimization. Out of the 10, - Bethlehem, PA and Ontario, CA were defined as locations already decided. The 10 locations selected as options were as described in **figure 4-4**.



	Name	Abbr	Zip	IPLC	Lt De	Lt M	Lg De	Lg M	Echelon	ID #
1	THE MEADOWS KY	THE	40505		38	06	84	30	2	405
2	BETHLEHEM-1802PA	BETH	18020		40	38	75	23	2	180
3	ONTARIO INTERNCA	ONTA	91761		34	02	117	37	2	917
4	CINCINNATI OH	CINC	45202		39	08	84	30		1640
5	INDIANAPOLIS IN	INDI	46204		39	47	86	08		3480
6	LOUISVILLE KY	LOUI	40202		38	14	85	43		4520
7	WOODSTOCK IN	WOOD	47274		38	57	85	57		472
8	NASHVILLE TN	NASH	37202		36	05	87	00		5360
9	MEMPHIS TN	MEMF	38101		35	09	89	59		4920
10	DES MOINES IA	DES	50318		41	37	93	35		2120

Figure 4-4: 10 Optional locations for selecting 3 DCs

With the above constraints the model selected Meadows as the optimal location for the third DC, from the given set of choices and assigned customers to DCs as shown in **figure 4-5.**

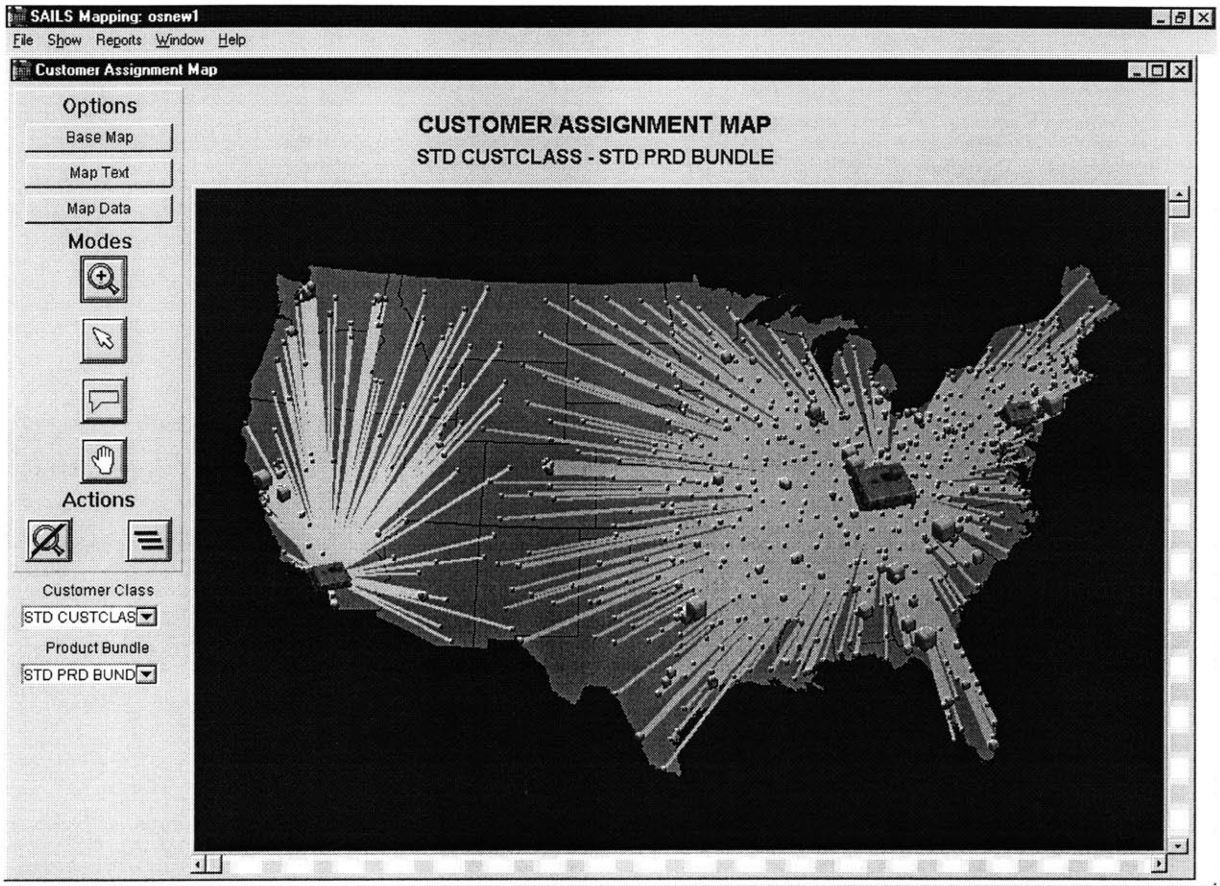


Figure 4-5: Customer Assignments in 3 DC network.

The system costs in this set of assignments were the same as described in **Table 4-1** for model OSNEW3 since the same customer demand is being assigned to the same 3 DCs.

The solver is minimizing the cost of satisfying customer demand from the 10 plants, moving the products through the DCs in different combinations. At Meadows, KY, the largest manufacturing plant is co-located with the DC. The solver automatically selects this as the DC location as a major portion of material movement from Meadows, KY to other DCs can be eliminated.

4.5 What if there was a capacity constraint on the DCs?

The next question was to test the robustness of this optimality. How would the customer assignments and the costs in the system change? Would the location of the third DC change?

To address these issues, the OSNEW1 model was taken as a base and modified to include additional capacity constraints. The results were checked at two levels of capacity constraints -- 150 million pounds and 100 million pounds and two levels of penalty for crossing the capacity limits - $1,000 & $100,000. The new models were labeled OS3NCAP8 and OS3NCAP5 for penalty of $1,000 and OS3CAPBI and OS5CAPBI for penalty cost of $100,000. At a capacity constraint of 150 million pounds, both runs (OS3NCAP8 and OS5CAPBI) indicated that Meadows, KY was the optimal location for the third DC. With low penalty cost, the solver found that Meadows was the optimal location even after paying a small penalty. With a low penalty cost, the solver identifies a solution with a low transportation cost and an admissible penalty. This could be viewed as the cost of additional space leased to enhance the capacity. A high penalty cost indicates that the capacity may not be increased and so the solver identifies a solution with no capacity violation but a higher transportation cost. The total cost for both solutions is within 1% in accordance with the tolerance limit set for the solver.

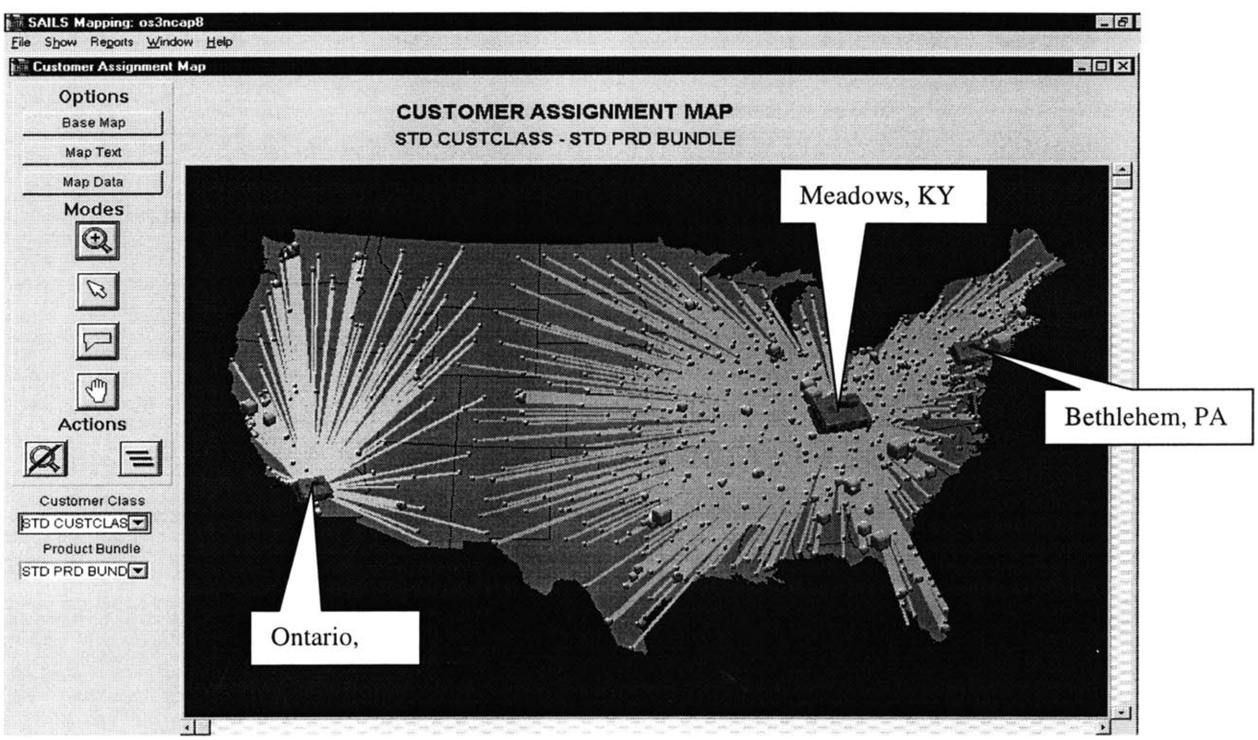


Figure 4-6 Customer Assignments Map in 3 DC network with capacity constraint of 150M & $1,000 penalty

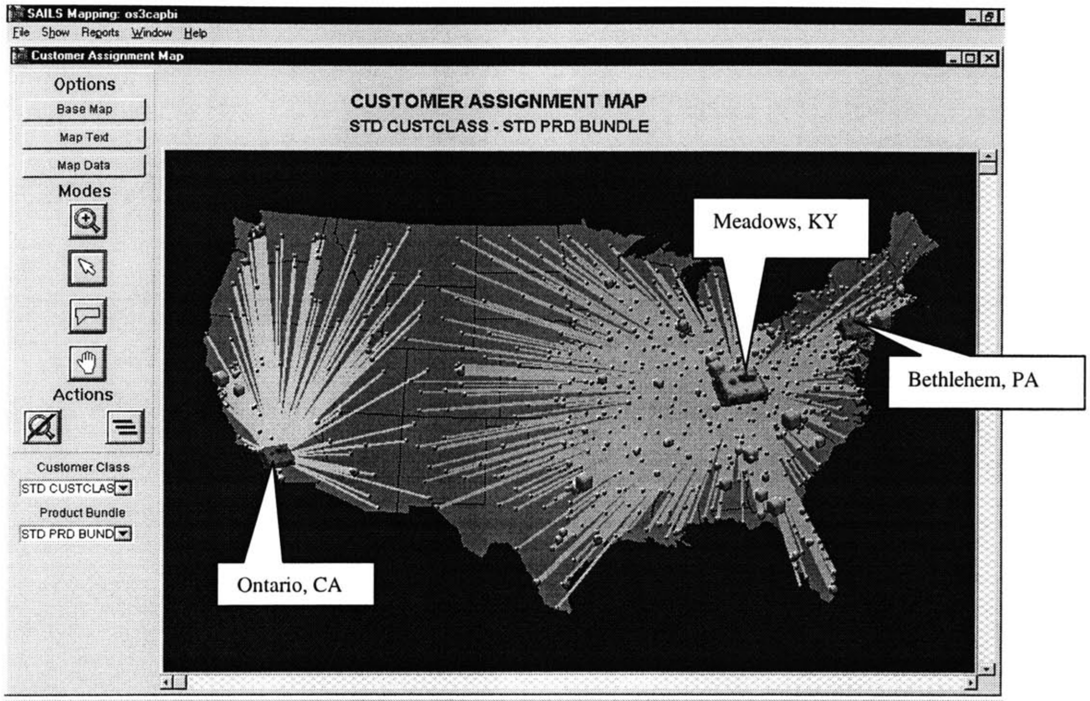


Figure 4-7 Customer Assignments in a 3 DC network with capacity constraint of 150M and penalty of $100,000

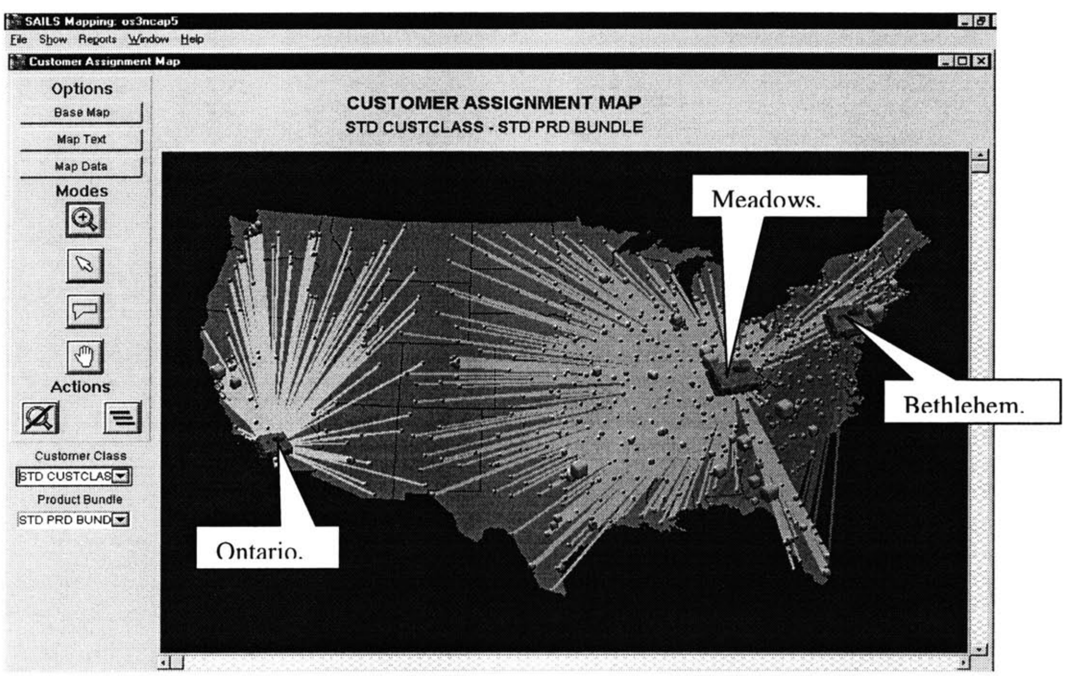


Figure 4-8: Customer Assignment map with 3 DC network at a capacity constraint of 100M

Table 4-3 Compares the costs in the system for the four conditions – no capacity constraint, and the 2 levels of capacity constraint with the penalties.

	OSNEW1	OS3NCap8	OS3CAPBI	OS3NCap5
	Choose 3/10	**Cap=150M**	**Cap=150M**	**Cap=100M (50%)**
		Pnlty=$1,000	**Pnlty=$100,0000**	
System-wide				
Volume Flow (CWT)	2,233,706	2,233,706	2,233,706	2,233,706
(Pounds)	223,370,600	223,370,600	223,370,600	223,370,600
Replenishment Cost	$ 23,729,000	$ 24,825,000	$ 24,934,000	$ 26,805,000
Outbound Cost	$ 25,346,000	$ 24,631,000	$ 24,884,000	$ 25,095,000
Facility Costs @1,000	$ 3,000	$ 3,000	$ 3,000	$ 3,000
Penalty Costs		$ 811,000	$ -	
Total Cost	$ 49,078,000	$ 50,270,000	$ 49,821,000	$ 51,903,000

Table 4-3: Comparison of system costs at different capacity and penalty levels

This analysis was conducted to analyze costs from a perspective of transportation costs. The facility costs were taken as the same nominal cost for the different capacity levels, so that the solver did not select more than the number of DCs wanted. In reality, the cost structure for DCs with different capacities would be different. SAILS is capable of including different fixed and variable costs for each candidate facility, but the issue was beyond the scope of this study.

A comparison of the different costs for the 3 DCs under the capacity constraint scenarios is given in **Table 4-3**. As can be seen from the figure ABC as well as TABLE XYZ, the customer allocations changed with available capacity. The service zone of the KY facility reduced with reduction in the allowable throughput. Correspondingly, the service area for the Bethlehem, PA facility increased. As capacity decreased, customer assignments migrated from Meadows KY to Bethlehem, PA. The solver seeks to minimize the total of the system and so it recalculated all the assignments and chose the combination of assignments that was the lowest in costs subject to the capacity constraints. The customer assignments that switched were located closer to the Bethlehem facility and resulted in a lower increase in the total cost as compared to the other customers.

	OSNEW1	OS3NCap8	OS3CAPBI	OS3NCap5
	Choose 3/10	Cap=150M	Cap=150M	Cap=100M
		Pnlty=$1,000	Pnlty=$100,000	
Bethlehem Flow	41,974	351,017	359,136	859,129
Cost in	641	4,521	4,586	10,866
Cost Out	506	3,561	4,189	9,425
Total Cost (1000$)	1,147	8,082	8,775	20,291
Overall Demand Wt Avg	93.41	126.35	156.86	370.80
Avg Cost / CWT	27.33	23.02	24.43	23.62
Ontario Flow	374,577	374,577	374,577	374,577
Cost in	6,980	6,980	6,980	6,980
Cost Out	3,754	3,754	3,754	3,754
Total Cost	10,734	10,734	10,734	10,734
Overall Demand Wt Avg	460.62	460.62	460.62	460.62
Avg Cost / CWT	28.66	28.66	28.66	28.66
Meadows Ky - Flow	1,817,155	1,508,112	1,499,993	1,000,000
Cost in	16,107	13,324	13,369	8,959
Cost Out	21,086	17,316	16,941	11,916
Total Cost	37,193	30,640	30,310	20,875
Overall Demand Wt Avg			543.90	568.64
Avg Cost / CWT	20.47	20.32	20.21	20.88

Table 4-4: Comparison of costs at the DCs for different capacity and penalty conditions

It was found that changes in the capacity constraint did not switch any customers between Meadows, KY and Ontario, CA. Most production for the products takes place in the eastern part of the country, and the products served out of the CA facility moved there before shipment to customers. The increase in costs for switching customers from KY to CA were higher than the increase due to switching from KY to PA and hence the solver chose to change assignments for the KY to PA pairs.

It was notable that the system costs were lower with the third DC at KY rather than they would be with locating the third DC any of the other 7 options that were considered. In fact, the solver found that it would be more cost effective to pay a penalty for overshooting the capacity limitation as opposed to reassigning a customer to another DC. This also means that the next lowest cost for changing the allocation of a customer was at least equivalent to the penalty amount and to change the assignment of a customer would have increased the transportation costs on that lane beyond the amount.

This exercise was not intended to arrive at the optimal capacity for the DC but only to check the sensitivity of the location selection to capacity constraints. However, the solutions described here are within 1% of the optimal solution.

4.6. How could it be known whether 3 was the correct number of DCs to have?

The next important issue in supply chain network design would be to determine the optimal number of DCs. Should it have been 4? Or 5?

In order to analyze this issue, additional models were formulated to study the costs if the models had to choose 4 or 5 DC locations from the same set of options. For the 4 DC model, the solver chose Meadows, KY and Des Moines, IA in addition to the 2 DCs that were locked open. Interestingly, it still chose to locate a DC at Meadows, KY. Figure 4-10 shows the customer assignment map for a 4 DC network.

In the 5 DC model, Meadows, KY and Des Moines, IA and Nashville, TN were the selected optimal choices for the DC locations in addition to the 2 facilities that were locked open.

Figure 4-11 shows the customer assignment map for a 5 DC network.

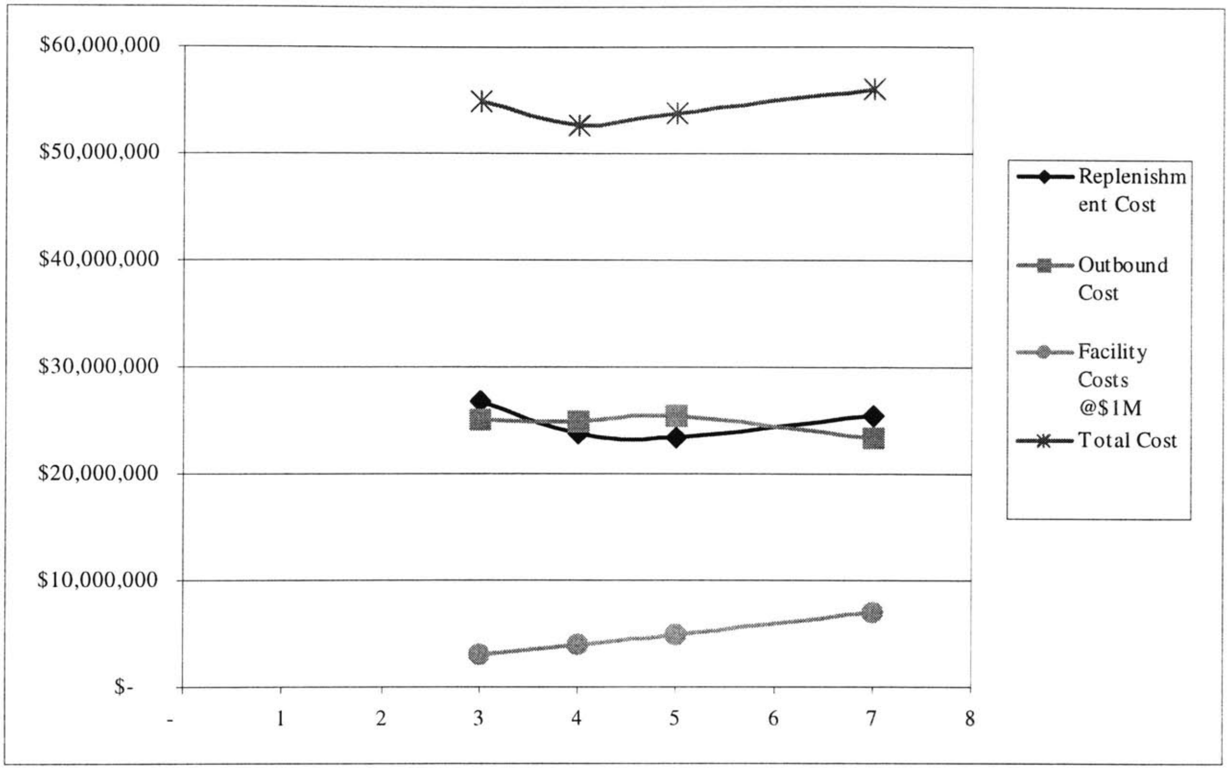


Figure 4-9 Total cost Vs Number of DCs

Figure 4.9 confirms that there will be an optimal number of facilities that will, minimize the total transportation cost of the system. In this case, a cost of $ 1 million was taken as the facility cost to illustrate the point. In reality, this figure would be dependent on the location and size of the facility and probably vary from place to place.

As the number of facilities increases, the products are placed farther out into the field and so beyond an optimal minimum, the replenishment costs begin to increase. Simultaneously, Since the products are closer to the customers, the outbound costs decrease. Hence, there is a trade-off between the inbound and the outbound costs. In the given case, the total cost of transportation changes with the number of DCs as per table 4-5.

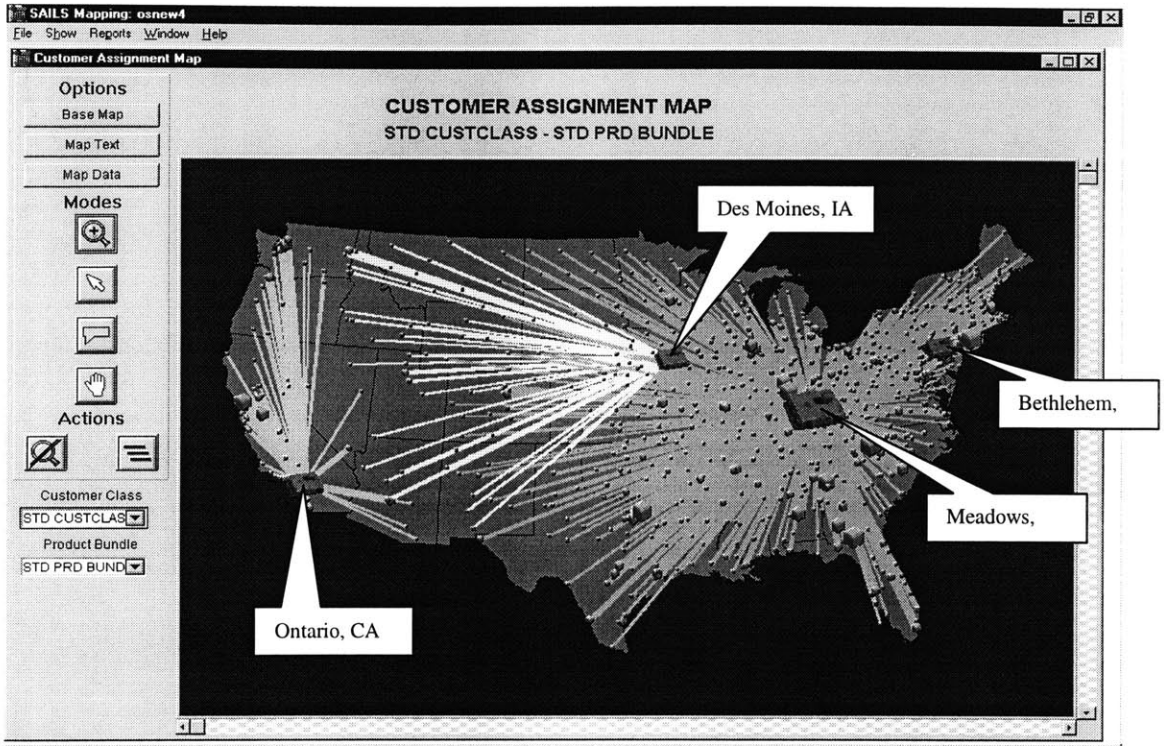


Figure 4-10: Customer assignment map for a 4 DC network

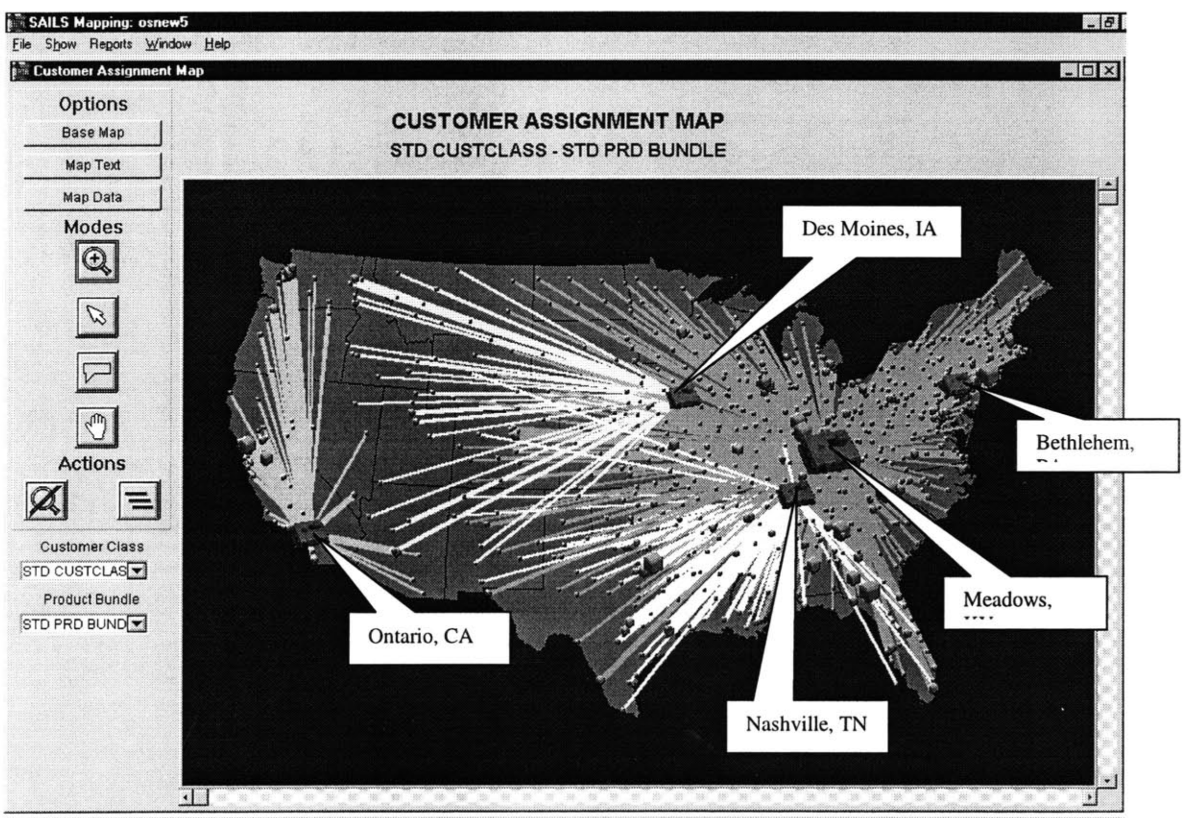


Figure 4-11 Customer Assignment map for a 5 DC network

Increasing the number of facilities increases the facility fixed costs. Although figure 4.9 shows that fixed facility costs are linear, most often they will not be. A larger number of facilities will spread the same demand is spread over a larger number of DCs and this would imply that each facility can now be smaller, making the costs non-linear. Since the general trend will still be increasing, the assumption about linearity can be made here.

The recommendation for a fourth facility is based on the savings from the reduction in transportation and a nominal fixed facility cost of $ 1 million per facility. In actuality, costs may vary from facility to facility. In order to assess the practical feasibility of the fourth facility, detailed assessment of the costs involved will be required. The facility will be viable only if the savings from transportation are higher than the costs that will be incurred in operating the fourth facility.

Appendix 4 and Appendix 5 give histograms of customer service in the 4 DC and the 5 DC scenario respectively.

	OSNEW1	OS7FTL	OSNEW4	OSNEW5
	Choose 3/10	**Existing 7**	**Choose 4/10**	**Choose 5/10**
System-wide				
Volume Flow (CWT)	2,233,706	2,233,706	2,233,706	2,233,706
(Pounds)	223,370,600	223,370,600	223,370,600	223,370,600
Replenishment Cost	$ 23,729,000	$ 25,554,000	$ 23,445,000	$ 23,770,000
Outbound Cost	$ 25,346,000	$ 23,440,000	$ 25,414,000	$ 24,944,000
Total Transportation Cost	$ 49,078,000	$ 48,994,000	$ 48,559,000	$ 48,714,000

Table 4-5: Comparison of Total Transportation costs at different number of DCs

Chapter 5. Summary and Conclusions

5.1. Overview:

The study targeted to analyze some of the issues that the company was concerned with, in their initiatives to reconfigure their distribution channels by shutting down some DCs and removing an entire echelon from the chain. The issues that were addressed concerned the impact of the change in network configuration for the manufacturer having a widespread customer base to be serviced from a reducing number of customer facing points. Data from the company was formulated into a network model and the SAILS ODS was used as the solver for optimization. The main questions that guided the study were:

1. What is the impact of reducing the number of DCs ?
2. What would be the optimal location of a third DC assuming 2 DCs are known?
3. What would be the customer allocations in the new network with 3 DCs?
4. How would the assignments change if there was a capacity constraint posed on the DCs?

A uniqueness of this network is that almost all of the production takes place in the eastern part of the country. A DC on the Western side could serve only the customers on the west in a cost-effective way. To serve more customers from the CA facility would imply that products are shipped to the West Coast from the east and then shipped eastwards again. This would be like backtracking material flows, which would result in higher costs.

The analysis found that it was indeed more cost effective to reduce the number of DCs. However, results showed that the total system costs comprising of the transportation and facility costs were lower for a 4 DC network as compared to a 3 DC network as planned by the company. The trade-off between facility cost, inbound and outbound costs yield maximum advantage when the number of DCs was at 4.

The existing facilities at Bethlehem, PA and Ontario, CA were to be definitely kept operational. The solver selected Meadows, KY as the optimal location for the third DC. This was because the KY facility is co-located with a manufacturing plant where 47% of the total volume of products is made. This implies that to supply to a customer from a DC location other than KY would cost more than to ship it from KY itself. That is the main reason why the solver tends to converge all demand to the DC at Meadows, KY.

Meadows, KY was the largest DC in the system, serving about 81% of the country's total demand when no capacity limitation was imposed. A capacity limitation on this facility caused some customers to be assigned to Bethlehem, PA. The demand weighted average distance changed from 570.92 to 543.90 for that DC and increased from 93.41 to 156.86 for Bethlehem when a capacity limit of 150 million pounds was imposed.

5.2. Summary of results

There are trade-offs in changing the number of customer facing points (Distribution Centers):

1. There will be reduction in the inbound transportation costs for the warehouse (cost of transportation from plants to warehouses). The additional stoppage at the CDC is eliminated, reducing the material handling and transportation costs.
2. There is an increase in outbound transportation costs (cost of transportation from distribution centers to customers) as the facilities are now located farther from the customers.
3. There is a reduction in the overhead and setup costs as the number of facilities is reduced.
4. A reduction in the inventory carrying costs since the total safety stock in the system goes down with the number of stocking points (square root law). The uncertainties in customer demand are met from a smaller pool of inventory.
5. The average travel time to customers increases with fewer distribution centers. This has an adverse effect on customer service levels.

5.3. Recommendations

The optimality of the network design can have a direct influence on the costs and the profitability of a company. The important design parameters discussed in the study that had the maximum impact were :

1. the number of DCs
2. the location of the DCs
3. capacity of the DCs.

In order for the reconfiguring of the network to have maximum benefit, the following is recommended:

1. The company should proceed with its plans to reduce the number of DCs from 7. However, the option of having 4 DCs instead of 3 should definitely be explored.
2. Meadows, KY, by virtue of its co-location with the largest manufacturing plant, is the ideal location for the third facility. The product made at that plant is the product with the single largest demand and so there is a natural tendency for location of a facility there.

   In case the plan for a fourth facility is followed, the optimal location for that will be Des Moines, IA. Indianapolis, IN was also a strong candidate for the location of the fourth DC.

3. The customer service strategy determines the maximum distance to customer that can be served from a given facility. This is perhaps the most important parameter that will decide the extent of the service zone and hence the capacity of the DC. The company should clearly define its policies on this issue before actually sizing the facility. The Bethlehem, PA and the Ontario, CA facilities already exist. It will be a good strategy for the company to study the possibility of expansion at these facilities and incorporate that while deciding the capacity of the Meadows facility.

5.4. Possible improvements to the study

SAILS is a powerful tool that can be used to model a supply chain network to great detail. With proper training, a network can be accurately represented in the model. The scope of this thesis was scaled down to a study that would be do-able in the time available and yet add value to the instruction provided in the program. Time permitting, the scope of the study could have been expanded to include a greater depth of detail in the models. Some of the main areas where this could be possible are enumerated below.

1. Aggregation of data

   The data used for the study was aggregated from transactions that took place over the previous one year. As in any aggregation, there was some loss of detail that occurred. SAILS allows the use of transaction data which the software itself analyzes for seasonality and trends that may influence results of the study.

2. Transportation rates.

   Transportation rates were based on the Yellow 500, 1999 rates for shipments that moved last year by truckload, LTL or were picked up by the customers themselves. The advantage of this approach was that there was uniformity for all possible lanes and combinations. The disadvantage of this approach was that truckload and LTL shipments were both costed at the same rate, when in reality, a truckload shipment will be costed at a cheaper rate over an LTL shipment in the same weight break.

3. Basis for costing flows

   All calculations for flows were based on the weight of the shipments moving between the nodes. In the lighting equipment industry, shipments containing products like incandescent bulbs will cube-out whereas shipments containing products like ballast will weigh-out. A truckload of incandescent bulbs will weigh much less than a truckload of ballast. It was assumed that the product mix for all customers would weigh similarly and this would not cause any discrepancy in the results. SAILS does have the option to define the profile for each product. Incorporating this in the study would have complicated the model beyond the scope of the study.

4. Solver Tolerance

   All results given by the solver were within 1% of the optimal as that was the tolerance limit set for the study. A tighter tolerance would have required higher computing power and longer time for each run of the model. There are a large number of solutions at each level of tolerance. As the tolerance is tightened, the solver requires a larger number of iterations and so the time requirement increases exponentially. As a next step, the tolerance limit can be set tighter to achieve results closer to the optimal if so desired.

5.5. Further Steps

Supply Chain network optimization is a strategic decision for the company that will impact the profitability over a long period of time – 4 ~ 5 years. SAILS ODS is a decision support tool that enables the management to take decisions regarding the issues on number of facilities, facility location, customer assignment, etc., as discussed in this paper. It is not capable of doing a sensitivity analysis on parameters without a re-modeling exercise. Testing the sensitivity of the model solution to variances can help the management of the company make better informed decisions.

The immediate issue for analysis will probably to decide on the size of the third DC at Meadows, KY. This will require clear inputs regarding the customer service limitations from the management. The capacity will be based on the peak throughput at the DC. That information can be obtained through a simulation tool that can take input from the SAILS solver regarding the network model.

Network optimization can be an on-going exercise, even from a strategic perspective to continuously monitor its optimality and decide on the next change with even better data. Some of the areas where improvement can be made are discussed below:

Some of the other issues that were identified during the study related to the new network design without the Central DCs where individual shipments could be consolidated. The company management will need to look at these issues also to make its network optimization effective:

1) In reality, demand will be probabilistic and manufacturing capacity limited. Hence, in the direct to DC deployment scenario, the product-planning schedule will have to incorporate information on where the product will be deployed. The absence of an agile and responsive forecasting system can result in product in the wrong place and having to be re-deployed to another location. In such a scenario, the location with excess inventory will become a potential supplier for the shortage location, but indiscriminate shipping can result in this location having shortages in the next time window.

2) The existing information and management systems would have been designed for the 3-echelon system. Reconfiguration of the network will probably require a change in these systems. The management will require to ensure changes in the systems before change is implemented.

This thesis highlights the differences that emerge from a mathematical solution to a real world situation and how the result are modified to give less than optimal solutions. The solutions thus obtained are "optimal" under the constraints and the model that was defined.

It was assumed that the plant locations will not change. The product mix was not changed and the demand pattern also remained the same. The objective was to design or reconfigure the logistics network so as to minimize the annual systemwide costs. This includes production and purchasing costs, inventory holding costs, facility costs and transportation costs. Facility costs arise from the fixed costs at the facility, storage and handling of products. These are likely to vary with location of the facility depending on real estate costs in the area, availability of labor, etc. (For the purpose of this study, these costs are assume to be constant over the selection of the location and hence ignored for calculations.) The transportation costs are also likely to vary with location of the facility depending on volume of total freight inbound to and out bound from the area where the facility is planned to be located. The selection of the mode of transportation is key to the cost. (In the model here, it is assumed to be constant for a given customer, independent of the location of the DC that customer will be served from)

There is a lot that can be done towards improving any supply chain or even a part of it. In this study, the focus was improvement of the distribution system using a supply chain network modeling tool. The strong interrelationship between some of key decision areas in a logistics system design was studied to arrive at recommendations to some of the issues. Even tough the actual situation may have been unique for the company in terms of its product range, and manufacturing system, these issues were identical to what any company wanting to alter even a part its supply chain network would face. The key results were presented and analyzed to make recommendations for the company. This study can serve as the starting point for a change and so some points for further study were also identified, not omitting some of the future improvements possible in a similar study.

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Appendices

Appendix-1

SOLVER REPORTS — CUSTOMER ASSIGNMENT MAP KEY — SAILS: REL 99-1C

REPORT #: 56-019 — 22 APRL 0

PAGE 46 — CUSTOMER CLASS : 1 STD CUSTCLASS — PRODUCT BUNDLE : 1 STD PRD BUNDLE — osnew1

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT		CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	
7 CHICOPEE	MA	(A)	1 THE MEADOWS	KY	8 SPRINGFIELD	MA	(A)	1 THE MEADOWS	KY
9 PITTSFIELD	MA	(A)	1 THE MEADOWS	KY	10 GREENFIELD	MA	(A)	1 THE MEADOWS	KY
11 FITCHBURG	MA	(A)	1 THE MEADOWS	KY	12 SHREWSBURY	MA	(A)	1 THE MEADOWS	KY
13 WORCESTER	MA	(A)	1 THE MEADOWS	KY	14 FRAMINGHAM	MA	(A)	1 THE MEADOWS	KY
15 MIDDLESEX-ESS	MA	(A)	1 THE MEADOWS	KY	16 LYNN	MA	(A)	1 THE MEADOWS	KY
17 NORWOOD	MA	(A)	1 THE MEADOWS	KY	18 CAMBRIDGE	MA	(A)	1 THE MEADOWS	KY
19 BOSTON	MA	(A)	1 THE MEADOWS	KY	20 PLYMOUTH	MA	(A)	1 THE MEADOWS	KY
21 BROCKTON	MA	(A)	1 THE MEADOWS	KY	22 BUZZARDS BAY	MA	(A)	1 THE MEADOWS	KY
23 CENTERVILLE	MA	(A)	1 THE MEADOWS	KY	24 NEW BEDFORD	MA	(A)	1 THE MEADOWS	KY
25 PAWTUCKET	RI	(A)	1 THE MEADOWS	KY	26 PROVIDENCE	RI	(A)	1 THE MEADOWS	KY
27 NASHUA	NH	(A)	1 THE MEADOWS	KY	28 MANCHESTER	NH	(A)	1 THE MEADOWS	KY
29 LACONIA	NH	(A)	1 THE MEADOWS	KY	30 CONCORD	NH	(A)	1 THE MEADOWS	KY
31 KEENE	NH	(A)	1 THE MEADOWS	KY	32 BERLIN	NH	(A)	1 THE MEADOWS	KY
33 WAPOLE	NH	(A)	1 THE MEADOWS	KY	34 LEBANON	NH	(A)	1 THE MEADOWS	KY
35 PORTSMOUTH	NH	(A)	1 THE MEADOWS	KY	36 YORK	ME	(A)	1 THE MEADOWS	KY
37 BIDDEFORD	ME	(A)	1 THE MEADOWS	KY	38 PORTLAND	ME	(A)	1 THE MEADOWS	KY
39 LEWISTON	ME	(A)	1 THE MEADOWS	KY	40 AUGUSTA	ME	(A)	1 THE MEADOWS	KY
41 BANGOR	ME	(A)	1 THE MEADOWS	KY	42 BATH	ME	(A)	1 THE MEADOWS	KY
43 CALAIS	ME	(A)	1 THE MEADOWS	KY	44 PRESQUE ISLE	ME	(A)	1 THE MEADOWS	KY
45 ROCKLAND	ME	(A)	1 THE MEADOWS	KY	46 WATERVILLE	ME	(A)	1 THE MEADOWS	KY
47 WHITE RIVER J	VT	(A)	1 THE MEADOWS	KY	48 SPRINGFIELD	VT	(B)	2 BETHLEHEM-1802	PA
49 BENNINGTON	VT	(A)	1 THE MEADOWS	KY	50 BRATTLEBORO	VT	(A)	1 THE MEADOWS	KY
51 BURLINGTON	VT	(A)	1 THE MEADOWS	KY	53 MONTPELIER	VT	(A)	1 THE MEADOWS	KY
54 RUTLAND	VT	(A)	1 THE MEADOWS	KY	55 ORLEANS	VT	(A)	1 THE MEADOWS	KY
57 NEW BRITAIN	CT	(A)	1 THE MEADOWS	KY	58 HARTFORD	CT	(A)	1 THE MEADOWS	KY
59 WINDHAM	CT	(B)	2 BETHLEHEM-1802	PA	60 NORWICH	CT	(B)	2 BETHLEHEM-1802	PA
61 FAIRFIELD	CT	(A)	1 THE MEADOWS	KY	62 NEW HAVEN	CT	(A)	1 THE MEADOWS	KY
63 BRIDGEPORT	CT	(A)	1 THE MEADOWS	KY	64 WATERBURY	CT	(A)	1 THE MEADOWS	KY
65 NORWALK	CT	(A)	1 THE MEADOWS	KY	66 STAMFORD	CT	(A)	1 THE MEADOWS	KY
67 EAST ORANGE	NJ	(A)	1 THE MEADOWS	KY	68 NEWARK	NJ	(A)	1 THE MEADOWS	KY
69 ELIZABETH	NJ	(A)	1 THE MEADOWS	KY	70 JERSEY CITY	NJ	(A)	1 THE MEADOWS	KY
71 WAYNE	NJ	(A)	1 THE MEADOWS	KY	72 PATERSON	NJ	(A)	1 THE MEADOWS	KY
73 HACKENSACK	NJ	(A)	1 THE MEADOWS	KY	74 MONMOUTH	NJ	(A)	1 THE MEADOWS	KY
75 DOVER	NJ	(A)	1 THE MEADOWS	KY	76 MORRISTOWN	NJ	(A)	1 THE MEADOWS	KY
77 CHERRY HILL	NJ	(A)	1 THE MEADOWS	KY	78 CAMDEN	NJ	(A)	1 THE MEADOWS	KY
79 PLEASANTVILLE	NJ	(B)	2 BETHLEHEM-1802	PA	80 VINELAND	NJ	(A)	1 THE MEADOWS	KY
81 ATLANTIC CITY	NJ	(B)	2 BETHLEHEM-1802	PA	82 PRINCETON	NJ	(A)	1 THE MEADOWS	KY
83 TRENTON	NJ	(A)	1 THE MEADOWS	KY	84 TOMS RIVER	NJ	(A)	1 THE MEADOWS	KY
85 EDISON	NJ	(B)	2 BETHLEHEM-1802	PA	86 NEW BRUNSWICK	NJ	(A)	1 THE MEADOWS	KY
87 NEW YORK 1	NY	(A)	1 THE MEADOWS	KY	88 NEW YORK 2	NY	(B)	2 BETHLEHEM-1802	PA
89 NEW YORK 3	NY	(A)	1 THE MEADOWS	KY	90 TOMPKINSVILLE	NY	(A)	1 THE MEADOWS	KY
91 BRONX	NY	(A)	1 THE MEADOWS	KY	92 MOUNT VERNON	NY	(A)	1 THE MEADOWS	KY
93 WESTCHESTER C	NY	(A)	1 THE MEADOWS	KY	94 YONKERS	NY	(A)	1 THE MEADOWS	KY
95 NEW ROCHELLE	NY	(A)	1 THE MEADOWS	KY	96 PALISADES	NY	(A)	1 THE MEADOWS	KY

CUSTOMER CLASS : 1 STD CUSTCLASS PRODUCT BUNDLE : 1 STD PRD BUNDLE osnew1

CUSTOMER REGION			SYMBOL	DC ASSIGNMENT		CUSTOMER REGION			SYMBOL	DC ASSIGNMENT	
97	FLORAL PARK	NY	(A)	1 THE MEADOWS	KY	98	SUNNYSIDE	NY	(A)	1 THE MEADOWS	KY
99	BROOKLYN	NY	(A)	1 THE MEADOWS	KY	100	QUEENS CENTER	NY	(A)	1 THE MEADOWS	KY
101	JAMAICA	NY	(A)	1 THE MEADOWS	KY	102	MINEOLA	NY	(B)	2 BETHLEHEM-1802	PA
103	FAR ROCKAWAY	NY	(A)	1 THE MEADOWS	KY	104	HAUPPAUGE	NY	(A)	1 THE MEADOWS	KY
105	HICKSVILLE	NY	(A)	1 THE MEADOWS	KY	106	SOUTHAMPTON	NY	(B)	2 BETHLEHEM-1802	PA
107	AMSTERDAM	NY	(A)	1 THE MEADOWS	KY	108	TROY	NY	(A)	1 THE MEADOWS	KY
109	ALBANY	NY	(A)	1 THE MEADOWS	KY	110	SCHENECTADY	NY	(A)	1 THE MEADOWS	KY
111	KINGSTON	NY	(A)	1 THE MEADOWS	KY	112	NEWBURGH	NY	(B)	2 BETHLEHEM-1802	PA
113	POUGHKEEPSIE	NY	(A)	1 THE MEADOWS	KY	114	MONTICELLO	NY	(A)	1 THE MEADOWS	KY
115	GLENS FALLS	NY	(A)	1 THE MEADOWS	KY	116	PLATTSBURGH	NY	(A)	1 THE MEADOWS	KY
117	AUBURN	NY	(A)	1 THE MEADOWS	KY	118	OSWEGO	NY	(A)	1 THE MEADOWS	KY
119	SYRACUSE	NY	(A)	1 THE MEADOWS	KY	120	HERKIMER	NY	(A)	1 THE MEADOWS	KY
121	ROME	NY	(A)	1 THE MEADOWS	KY	122	UTICA	NY	(A)	1 THE MEADOWS	KY
123	WATERTOWN	NY	(A)	1 THE MEADOWS	KY	124	ENDICOTT	NY	(A)	1 THE MEADOWS	KY
125	VESTAL	NY	(A)	1 THE MEADOWS	KY	126	BINGHAMTON	NY	(A)	1 THE MEADOWS	KY
127	LOCKPORT	NY	(A)	1 THE MEADOWS	KY	128	TONAWANDA	NY	(A)	1 THE MEADOWS	KY
129	BUFFALO	NY	(A)	1 THE MEADOWS	KY	130	NIAGRA FALLS	NY	(A)	1 THE MEADOWS	KY
131	CANADAIGUA	NY	(A)	1 THE MEADOWS	KY	132	NEWARK	NY	(A)	1 THE MEADOWS	KY
133	ROCHESTER	NY	(A)	1 THE MEADOWS	KY	134	JAMESTOWN	NY	(A)	1 THE MEADOWS	KY
135	ITHACA	NY	(A)	1 THE MEADOWS	KY	136	ELMIRA	NY	(A)	1 THE MEADOWS	KY
137	NEW KENSINGTN	PA	(A)	1 THE MEADOWS	KY	138	MCKEESPORT	PA	(A)	1 THE MEADOWS	KY
139	PITTSBURGH	PA	(A)	1 THE MEADOWS	KY	140	WASHINGTON	PA	(A)	1 THE MEADOWS	KY
141	UNIONTOWN	PA	(A)	1 THE MEADOWS	KY	142	SOMERSET	PA	(A)	1 THE MEADOWS	KY
143	GREENSBURG	PA	(A)	1 THE MEADOWS	KY	144	INDIANA	PA	(A)	1 THE MEADOWS	KY
145	DUBOIS	PA	(A)	1 THE MEADOWS	KY	146	JOHNSTOWN	PA	(A)	1 THE MEADOWS	KY
147	BUTLER	PA	(A)	1 THE MEADOWS	KY	148	NEW CASTLE	PA	(A)	1 THE MEADOWS	KY
149	CLARION	PA	(A)	1 THE MEADOWS	KY	150	OIL CITY	PA	(A)	1 THE MEADOWS	KY
151	CORRY	PA	(A)	1 THE MEADOWS	KY	152	ERIE	PA	(A)	1 THE MEADOWS	KY
153	ALTOONA	PA	(A)	1 THE MEADOWS	KY	154	BRADFORD	PA	(A)	1 THE MEADOWS	KY
155	STATE COLLEGE	PA	(A)	1 THE MEADOWS	KY	156	WELLSBORO	PA	(A)	1 THE MEADOWS	KY
157	CAMP HILL	PA	(A)	1 THE MEADOWS	KY	158	HARRISBURG	PA	(A)	1 THE MEADOWS	KY
159	CHAMBERSBURG	PA	(A)	1 THE MEADOWS	KY	160	HANOVER	PA	(A)	1 THE MEADOWS	KY
161	YORK	PA	(A)	1 THE MEADOWS	KY	162	EPHRATA	PA	(A)	1 THE MEADOWS	KY
163	LANCASTER	PA	(A)	1 THE MEADOWS	KY	164	WILLIAMSPORT	PA	(A)	1 THE MEADOWS	KY
165	SUNBURY	PA	(A)	1 THE MEADOWS	KY	166	POTTSVILLE	PA	(A)	1 THE MEADOWS	KY
167	BETHLEHEM	PA	(A)	1 THE MEADOWS	KY	168	ALLENTOWN	PA	(A)	1 THE MEADOWS	KY
169	HAZELTON	PA	(A)	1 THE MEADOWS	KY	170	EAST STROUDSB	PA	(B)	2 BETHLEHEM-1802	PA
171	CARBONDALE	PA	(B)	2 BETHLEHEM-1802	PA	172	SCRANTON	PA	(A)	1 THE MEADOWS	KY
173	PITTSTON	PA	(A)	1 THE MEADOWS	KY	174	WILKES-BARRE	PA	(A)	1 THE MEADOWS	KY
175	SAYRE	PA	(A)	1 THE MEADOWS	KY	176	WARMINSTER	PA	(A)	1 THE MEADOWS	KY
177	LEVITTOWN	PA	(A)	1 THE MEADOWS	KY	178	PHILADELPHIA	PA	(A)	1 THE MEADOWS	KY
180	WEST CHESTER	PA	(A)	1 THE MEADOWS	KY	181	NORRISTOWN	PA	(A)	1 THE MEADOWS	KY
182	KUTZTOWN	PA	(B)	2 BETHLEHEM-1802	PA	183	READING	PA	(A)	1 THE MEADOWS	KY
184	NEWARK	DE	(A)	1 THE MEADOWS	KY	185	WILMINGTON	DE	(A)	1 THE MEADOWS	KY
186	DOVER	DE	(A)	1 THE MEADOWS	KY	187	WASHINGTON	DC	(A)	1 THE MEADOWS	KY
188	STERLING	VA	(A)	1 THE MEADOWS	KY	189	UNITED STATES	DC	(A)	1 THE MEADOWS	KY

CUSTOMER ASSIGNMENT MAP KEY

SAILS: REL 99-1C
22 APRL 0
osnew1

CUSTOMER CLASS : 1 STD CUSTCLASS   PRODUCT BUNDLE : 1 STD PRD BUNDLE

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT		CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	
190 PENTAGON	DC	(A)	1 THE MEADOWS	KY	191 GEN SVCS ADMIN	DC	(A)	1 THE MEADOWS	KY
192 SMITHSONIAN	DC	(A)	1 THE MEADOWS	KY	193 WALDORF	MD	(A)	1 THE MEADOWS	KY
194 COLLEGE PARK	MD	(A)	1 THE MEADOWS	KY	195 ROCKVILLE	MD	(A)	1 THE MEADOWS	KY
196 SILVER SPRING	MD	(A)	1 THE MEADOWS	KY	197 COLUMBIA	MD	(A)	1 THE MEADOWS	KY
198 WESTMINSTER	MD	(A)	1 THE MEADOWS	KY	199 BALTIMORE	MD	(A)	1 THE MEADOWS	KY
200 ANNAPOLIS	MD	(A)	1 THE MEADOWS	KY	201 CUMBERLAND	MD	(A)	1 THE MEADOWS	KY
202 EASTON	MD	(A)	1 THE MEADOWS	KY	203 FREDERICK	MD	(A)	1 THE MEADOWS	KY
204 SALISBURY	MD	(A)	1 THE MEADOWS	KY	205 ELKTON	MD	(B)	2 BETHLEHEM-1802	PA
206 FAIRFAX	VA	(A)	1 THE MEADOWS	KY	207 WOODBRIDGE	VA	(A)	1 THE MEADOWS	KY
208 ARLINGTON	VA	(B)	2 BETHLEHEM-1802	PA	209 ALEXANDRIA	VA	(B)	2 BETHLEHEM-1802	PA
210 FREDERICKSBRG	VA	(A)	1 THE MEADOWS	KY	211 TAPPAHANNOCK	VA	(A)	1 THE MEADOWS	KY
212 WINCHESTER	VA	(B)	2 BETHLEHEM-1802	PA	213 CULPEPER	VA	(A)	1 THE MEADOWS	KY
214 HARRISONBURG	VA	(A)	1 THE MEADOWS	KY	215 CHARLOTTESVIL	VA	(A)	1 THE MEADOWS	KY
216 HIGHLAND SPRG	VA	(A)	1 THE MEADOWS	KY	217 WILLIAMSBURG	VA	(A)	1 THE MEADOWS	KY
218 RICHMOND	VA	(A)	1 THE MEADOWS	KY	219 CHESAPEAKE	VA	(A)	1 THE MEADOWS	KY
220 VIRGINIA BCH	VA	(A)	1 THE MEADOWS	KY	221 NORFOLK	VA	(A)	1 THE MEADOWS	KY
222 NEWPORT NEWS	VA	(A)	1 THE MEADOWS	KY	223 PORTSMOUTH	VA	(A)	1 THE MEADOWS	KY
224 PETERSBURG	VA	(A)	1 THE MEADOWS	KY	225 FARMVILLE	VA	(A)	1 THE MEADOWS	KY
226 ROANOKE	VA	(A)	1 THE MEADOWS	KY	227 MARTINSVILLE	VA	(A)	1 THE MEADOWS	KY
228 BRISTOL	VA	(A)	1 THE MEADOWS	KY	229 PULASKI	VA	(A)	1 THE MEADOWS	KY
230 STAUNTON	VA	(A)	1 THE MEADOWS	KY	231 LYNCHBURG	VA	(A)	1 THE MEADOWS	KY
232 BLUEFIELD	VA	(A)	1 THE MEADOWS	KY	233 BLUEFIELD	WV	(A)	1 THE MEADOWS	KY
234 WELCH	WV	(A)	1 THE MEADOWS	KY	235 LEWISBURG	WV	(A)	1 THE MEADOWS	KY
236 DUNBAR	WV	(A)	1 THE MEADOWS	KY	237 NITRO	WV	(A)	1 THE MEADOWS	KY
238 RIPLEY	WV	(A)	1 THE MEADOWS	KY	239 CHARLESTON	WV	(A)	1 THE MEADOWS	KY
240 MARTINSBURG	WV	(A)	1 THE MEADOWS	KY	241 POINT PLEASNT	WV	(A)	1 THE MEADOWS	KY
242 WILLIAMSON	WV	(A)	1 THE MEADOWS	KY	243 HUNTINGTON	WV	(A)	1 THE MEADOWS	KY
244 BECKLEY	WV	(A)	1 THE MEADOWS	KY	245 OAK HILL	WV	(A)	1 THE MEADOWS	KY
246 WHEELING	WV	(A)	1 THE MEADOWS	KY	247 PARKERSBURG	WV	(A)	1 THE MEADOWS	KY
248 BUCKHANNON	WV	(A)	1 THE MEADOWS	KY	249 CLARKSBURG	WV	(A)	1 THE MEADOWS	KY
250 WESTON	WV	(A)	1 THE MEADOWS	KY	251 MORGANTOWN	WV	(A)	1 THE MEADOWS	KY
252 GASSAWAY	WV	(A)	1 THE MEADOWS	KY	253 KEYSER	WV	(A)	1 THE MEADOWS	KY
254 PETERSBURG	WV	(A)	1 THE MEADOWS	KY	255 CLEMMONS	NC	(A)	1 THE MEADOWS	KY
256 WINSTON-SALEM	NC	(A)	1 THE MEADOWS	KY	257 HIGH POINT	NC	(A)	1 THE MEADOWS	KY
258 SANFORD	NC	(A)	1 THE MEADOWS	KY	259 GREENSBORO	NC	(A)	1 THE MEADOWS	KY
260 CHAPEL HILL	NC	(A)	1 THE MEADOWS	KY	261 RALEIGH	NC	(A)	1 THE MEADOWS	KY
262 DURHAM	NC	(A)	1 THE MEADOWS	KY	263 ROCKY MOUNT	NC	(A)	1 THE MEADOWS	KY
264 ELIZABETH CTY	NC	(A)	1 THE MEADOWS	KY	265 GASTONIA	NC	(A)	1 THE MEADOWS	KY
266 SALISBURY	NC	(A)	1 THE MEADOWS	KY	267 CHARLOTTE	NC	(A)	1 THE MEADOWS	KY
268 FAYETTEVILLE	NC	(A)	1 THE MEADOWS	KY	269 WILMINGTON	NC	(A)	1 THE MEADOWS	KY
270 KINSTON	NC	(A)	1 THE MEADOWS	KY	271 HICKORY	NC	(A)	1 THE MEADOWS	KY
272 HENDERSONVILL	NC	(A)	1 THE MEADOWS	KY	273 ASHEVILLE	NC	(A)	1 THE MEADOWS	KY
274 MURPHY	NC	(A)	1 THE MEADOWS	KY	275 LEXINGTON	SC	(A)	1 THE MEADOWS	KY
276 SUMTER	SC	(A)	1 THE MEADOWS	KY	277 COLUMBIA	SC	(A)	1 THE MEADOWS	KY
278 SPARTANBURG	SC	(A)	1 THE MEADOWS	KY	279 CHARLESTON	SC	(A)	1 THE MEADOWS	KY
280 FLORENCE	SC	(A)	1 THE MEADOWS	KY	281 GREENVILLE	SC	(A)	1 THE MEADOWS	KY

CUSTOMER CLASS : 1 STD CUSTCLASS PRODUCT BUNDLE : 1 STD PRD BUNDLE osnew1

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT		CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	
282 ROCK HILL	SC	(A)	1 THE MEADOWS	KY	283 AIKEN	SC	(A)	1 THE MEADOWS	KY
284 HILTON HEAD	SC	(A)	1 THE MEADOWS	KY	285 MARIETTA	GA	(A)	1 THE MEADOWS	KY
286 ROME	GA	(A)	1 THE MEADOWS	KY	287 LA GRANGE	GA	(A)	1 THE MEADOWS	KY
288 ATLANTA	GA	(A)	1 THE MEADOWS	KY	289 SWAINSBORO	GA	(A)	1 THE MEADOWS	KY
290 GAINESVILLE	GA	(A)	1 THE MEADOWS	KY	291 ATHENS	GA	(A)	1 THE MEADOWS	KY
292 DALTON	GA	(A)	1 THE MEADOWS	KY	293 THOMSON	GA	(A)	1 THE MEADOWS	KY
294 AUGUSTA	GA	(A)	1 THE MEADOWS	KY	295 WARNER ROBBNS	GA	(A)	1 THE MEADOWS	KY
297 MACON	GA	(A)	1 THE MEADOWS	KY	298 HINESVILLE	GA	(A)	1 THE MEADOWS	KY
299 SAVANNAH	GA	(A)	1 THE MEADOWS	KY	300 WAYCROSS	GA	(A)	1 THE MEADOWS	KY
301 VALDOSTA	GA	(A)	1 THE MEADOWS	KY	302 ALBANY	GA	(A)	1 THE MEADOWS	KY
303 MANCHESTER	GA	(A)	1 THE MEADOWS	KY	304 COLUMBUS	GA	(A)	1 THE MEADOWS	KY
305 ST AUGUSTINE	FL	(A)	1 THE MEADOWS	KY	306 DAYTONA BEACH	FL	(A)	1 THE MEADOWS	KY
307 JACKSONVILLE	FL	(A)	1 THE MEADOWS	KY	308 TALLAHASSEE	FL	(A)	1 THE MEADOWS	KY
309 PANAMA CITY	FL	(A)	1 THE MEADOWS	KY	310 PENSACOLA	FL	(A)	1 THE MEADOWS	KY
311 GAINESVILLE	FL	(A)	1 THE MEADOWS	KY	312 TITUSVILLE	FL	(A)	1 THE MEADOWS	KY
313 ORLANDO	FL	(A)	1 THE MEADOWS	KY	314 MELBOURNE	FL	(A)	1 THE MEADOWS	KY
315 HIALEAH	FL	(A)	1 THE MEADOWS	KY	316 MIAMI	FL	(A)	1 THE MEADOWS	KY
317 NORTH MIAMI	FL	(A)	1 THE MEADOWS	KY	318 FT LAUDERDALE	FL	(A)	1 THE MEADOWS	KY
319 WEST PALM BEA	FL	(A)	1 THE MEADOWS	KY	320 BRANDON	FL	(A)	1 THE MEADOWS	KY
321 TAMPA	FL	(A)	1 THE MEADOWS	KY	322 ST PETERSBURG	FL	(A)	1 THE MEADOWS	KY
323 LAKELAND	FL	(A)	1 THE MEADOWS	KY	324 FORT MYERS	FL	(A)	1 THE MEADOWS	KY
325 NAPLES	FL	(A)	1 THE MEADOWS	KY	326 SARASOTA	FL	(A)	1 THE MEADOWS	KY
327 OCALA	FL	(A)	1 THE MEADOWS	KY	328 CLEARWATER	FL	(A)	1 THE MEADOWS	KY
329 LEESBURG	FL	(A)	1 THE MEADOWS	KY	330 FORT PIERCE	FL	(A)	1 THE MEADOWS	KY
331 BESSEMER	FL	(A)	1 THE MEADOWS	KY	332 TALLADEGA	AL	(A)	1 THE MEADOWS	KY
333 BIRMINGHAM	AL	(A)	1 THE MEADOWS	KY	334 TUSCALOOSA	AL	(A)	1 THE MEADOWS	KY
335 JASPER	AL	(A)	1 THE MEADOWS	KY	336 DECATUR	AL	(A)	1 THE MEADOWS	KY
337 SCOTTSBORO	AL	(A)	1 THE MEADOWS	KY	338 HUNTSVILLE	AL	(A)	1 THE MEADOWS	KY
339 GADSDEN	AL	(A)	1 THE MEADOWS	KY	340 PRATTVILLE	AL	(A)	1 THE MEADOWS	KY
341 MONTGOMERY	AL	(A)	1 THE MEADOWS	KY	342 ANNISTON	AL	(A)	1 THE MEADOWS	KY
343 DOTHAN	AL	(A)	1 THE MEADOWS	KY	344 EVERGREEN	AL	(A)	1 THE MEADOWS	KY
345 ATMORE	AL	(A)	1 THE MEADOWS	KY	346 MOBILE	AL	(A)	1 THE MEADOWS	KY
347 SELMA	AL	(A)	1 THE MEADOWS	KY	348 AUBURN	AL	(A)	1 THE MEADOWS	KY
349 YORK	AL	(A)	1 THE MEADOWS	KY	350 CLARKSVILLE	TN	(A)	1 THE MEADOWS	KY
351 MURFREESBORO	TN	(A)	1 THE MEADOWS	KY	352 NASHVILLE	TN	(A)	1 THE MEADOWS	KY
353 CLEVELAND	TN	(A)	1 THE MEADOWS	KY	354 CHATTANOOGA	TN	(A)	1 THE MEADOWS	KY
356 JOHNSON CITY	TN	(A)	1 THE MEADOWS	KY	357 GREENVILLE	TN	(A)	1 THE MEADOWS	KY
358 OAK RIDGE	TN	(A)	1 THE MEADOWS	KY	359 KNOXVILLE	TN	(A)	1 THE MEADOWS	KY
360 MILLINGTON	TN	(A)	1 THE MEADOWS	KY	361 MEMPHIS	TN	(A)	1 THE MEADOWS	KY
362 MCKENZIE	TN	(A)	1 THE MEADOWS	KY	363 JACKSON	TN	(A)	1 THE MEADOWS	KY
364 COLUMBIA	TN	(A)	1 THE MEADOWS	KY	365 COOKEVILLE	TN	(A)	1 THE MEADOWS	KY
366 HOLLY SPRINGS	MS	(A)	1 THE MEADOWS	KY	367 GREENVILLE	MS	(A)	1 THE MEADOWS	KY
368 TUPELO	MS	(A)	1 THE MEADOWS	KY	369 GRENADA	MS	(A)	1 THE MEADOWS	KY
370 CLINTON	MS	(A)	1 THE MEADOWS	KY	371 VICKSBURG	MS	(A)	1 THE MEADOWS	KY
372 JACKSON	MS	(A)	1 THE MEADOWS	KY	373 MERIDIAN	MS	(A)	1 THE MEADOWS	KY
374 HATTIESBURG	MS	(A)	1 THE MEADOWS	KY	375 GULFPORT	MS	(A)	1 THE MEADOWS	KY
376 MCCOMB	MS	(A)	1 THE MEADOWS	KY	377 COLUMBUS	MS	(A)	1 THE MEADOWS	KY

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT		CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	
379 SHELBYVILLE	KY	(A)	1 THE MEADOWS	KY	380 RADCLIFF	KY	(A)	1 THE MEADOWS	KY
381 LOUISVILLE	KY	(A)	1 THE MEADOWS	KY	382 WINCHESTER	KY	(A)	1 THE MEADOWS	KY
383 RICHMOND	KY	(A)	1 THE MEADOWS	KY	384 LEXINGTON	KY	(A)	1 THE MEADOWS	KY
385 FRANKFURT	KY	(A)	1 THE MEADOWS	KY	386 LONDON	KY	(A)	1 THE MEADOWS	KY
387 CUMBERLAND	KY	(A)	1 THE MEADOWS	KY	388 MIDDLESBORO	KY	(A)	1 THE MEADOWS	KY
389 COVINGTON	KY	(A)	1 THE MEADOWS	KY	390 ASHLAND	KY	(A)	1 THE MEADOWS	KY
391 PAINTSVILLE	KY	(A)	1 THE MEADOWS	KY	392 CAMPTON	KY	(A)	1 THE MEADOWS	KY
394 PIKEVILLE	KY	(A)	1 THE MEADOWS	KY	395 AUXIER	KY	(A)	1 THE MEADOWS	KY
396 HAZARD	KY	(A)	1 THE MEADOWS	KY	397 WHITESBURG	KY	(A)	1 THE MEADOWS	KY
398 PADUCAH	KY	(A)	1 THE MEADOWS	KY	399 BOWLING GREEN	KY	(A)	1 THE MEADOWS	KY
400 HOPKINSVILLE	KY	(A)	1 THE MEADOWS	KY	401 OWENSBORO	KY	(A)	1 THE MEADOWS	KY
402 HENDERSON	KY	(A)	1 THE MEADOWS	KY	403 SOMERSET	KY	(A)	1 THE MEADOWS	KY
404 MONTICELLO	KY	(A)	1 THE MEADOWS	KY	405 ELIZABETHTOWN	KY	(A)	1 THE MEADOWS	KY
406 NEWARK	OH	(A)	1 THE MEADOWS	KY	407 LANCASTER	OH	(A)	1 THE MEADOWS	KY
408 COLUMBUS	OH	(A)	1 THE MEADOWS	KY	409 MARION	OH	(A)	1 THE MEADOWS	KY
410 BOWLING GREEN	OH	(A)	1 THE MEADOWS	KY	411 PERRYSBURG	OH	(A)	1 THE MEADOWS	KY
412 TOLEDO	OH	(A)	1 THE MEADOWS	KY	413 ZANESVILLE	OH	(A)	1 THE MEADOWS	KY
414 COSHOCTON	OH	(A)	1 THE MEADOWS	KY	415 STEUBENVILLE	OH	(A)	1 THE MEADOWS	KY
416 LORAIN	OH	(A)	1 THE MEADOWS	KY	417 CLEVELAND	OH	(A)	1 THE MEADOWS	KY
418 CUYAHOGA FALL	OH	(A)	1 THE MEADOWS	KY	419 AKRON	OH	(A)	1 THE MEADOWS	KY
420 WARREN	OH	(A)	1 THE MEADOWS	KY	421 YOUNGSTOWN	OH	(A)	1 THE MEADOWS	KY
422 MASSILLON	OH	(A)	1 THE MEADOWS	KY	423 CANTON	OH	(A)	1 THE MEADOWS	KY
424 SANDUSKY	OH	(A)	1 THE MEADOWS	KY	425 MANSFIELD	OH	(A)	1 THE MEADOWS	KY
426 HAMILTON	OH	(A)	1 THE MEADOWS	KY	427 WILMINGTON	OH	(A)	1 THE MEADOWS	KY
428 CINCINNATI	OH	(A)	1 THE MEADOWS	KY	429 MIAMISBURG	OH	(A)	1 THE MEADOWS	KY
430 DAYTON	OH	(A)	1 THE MEADOWS	KY	431 SPRINGFIELD	OH	(A)	1 THE MEADOWS	KY
432 CHILLICOTHE	OH	(A)	1 THE MEADOWS	KY	433 ATHENS	OH	(A)	1 THE MEADOWS	KY
434 LIMA	OH	(A)	1 THE MEADOWS	KY	436 ANDERSON	IN	(A)	1 THE MEADOWS	KY
437 GREENWOOD	IN	(A)	1 THE MEADOWS	KY	438 INDIANAPOLIS	IN	(A)	1 THE MEADOWS	KY
439 HAMMOND	IN	(A)	1 THE MEADOWS	KY	440 GARY	IN	(A)	1 THE MEADOWS	KY
441 ELKHARDT	IN	(A)	1 THE MEADOWS	KY	442 SOUTH BEND	IN	(A)	1 THE MEADOWS	KY
443 HUNTINGTON	IN	(A)	1 THE MEADOWS	KY	444 FORT WAYNE	IN	(A)	1 THE MEADOWS	KY
445 KOKOMO	IN	(A)	1 THE MEADOWS	KY	446 LAWRENCEBURG	IN	(A)	1 THE MEADOWS	KY
447 NEW ALBANY	IN	(A)	1 THE MEADOWS	KY	448 COLUMBUS	IN	(A)	1 THE MEADOWS	KY
449 MUNCIE	IN	(A)	1 THE MEADOWS	KY	450 BLOOMINGTON	IN	(A)	1 THE MEADOWS	KY
451 WASHINGTON	IN	(A)	1 THE MEADOWS	KY	452 NEWBURGH	IN	(A)	1 THE MEADOWS	KY
453 EVANSVILLE	IN	(A)	1 THE MEADOWS	KY	454 TERRE HAUTE	IN	(A)	1 THE MEADOWS	KY
455 LAFAYETTE	IN	(A)	1 THE MEADOWS	KY	456 ROYAL OAK	MI	(A)	1 THE MEADOWS	KY
457 ANN ARBOR	MI	(A)	1 THE MEADOWS	KY	458 DETROIT	MI	(A)	1 THE MEADOWS	KY
459 PONTIAC	MI	(A)	1 THE MEADOWS	KY	460 FLUSHING	MI	(A)	1 THE MEADOWS	KY
461 FLINT	MI	(A)	1 THE MEADOWS	KY	462 SAGINAW	MI	(A)	1 THE MEADOWS	KY
463 BAY CITY	MI	(A)	1 THE MEADOWS	KY	464 EAST LANSING	MI	(A)	1 THE MEADOWS	KY
465 LANSING	MI	(A)	1 THE MEADOWS	KY	466 KALAMAZOO	MI	(A)	1 THE MEADOWS	KY
467 NILES	MI	(A)	1 THE MEADOWS	KY	468 JACKSON	MI	(A)	1 THE MEADOWS	KY
469 BIG RAPIDS	MI	(A)	1 THE MEADOWS	KY	470 MUSKEGON	MI	(A)	1 THE MEADOWS	KY
471 GRAND RAPID	MI	(A)	1 THE MEADOWS	KY	472 TRAVERSE CITY	MI	(A)	1 THE MEADOWS	KY
473 GAYLORD	MI	(A)	1 THE MEADOWS	KY	474 IRON MOUNTAIN	MI	(A)	1 THE MEADOWS	KY

 CUSTOMER CLASS : 1 STD CUSTCLASS PRODUCT BUNDLE : 1 STD PRD BUNDLE osnew1

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	CUSTOMER REGION		SYMBOL	DC ASSIGNMENT
475 IRONWOOD	MI	(A)	1 THE MEADOWS KY	476 AMES	IA	(A)	1 THE MEADOWS KY
477 MARSHALLTOWN	IA	(A)	1 THE MEADOWS KY	478 W DES MOINES	IA	(A)	1 THE MEADOWS KY
479 DES MOINES	IA	(A)	1 THE MEADOWS KY	480 MASON CITY	IA	(A)	1 THE MEADOWS KY
481 FORT DODGE	IA	(A)	1 THE MEADOWS KY	482 CEDAR FALLS	IA	(A)	1 THE MEADOWS KY
483 WATERLOO	IA	(A)	1 THE MEADOWS KY	484 CRESTON	IA	(A)	1 THE MEADOWS KY
486 LE MARS	IA	(A)	1 THE MEADOWS KY	487 SIOUX CITY	IA	(A)	1 THE MEADOWS KY
489 SPENCER	IA	(A)	1 THE MEADOWS KY	490 CARROLL	IA	(A)	1 THE MEADOWS KY
491 COUNCIL BLUFF	IA	(A)	1 THE MEADOWS KY	492 SHENANDOAH	IA	(A)	1 THE MEADOWS KY
493 DUBUQUE	IA	(A)	1 THE MEADOWS KY	494 DECORAH	IA	(A)	1 THE MEADOWS KY
495 IOWA CITY	IA	(A)	1 THE MEADOWS KY	496 MARION	IA	(A)	1 THE MEADOWS KY
497 CEDAR RAPIDS	IA	(A)	1 THE MEADOWS KY	498 OTTUMWA	IA	(A)	1 THE MEADOWS KY
499 BURLINGTON	IA	(A)	1 THE MEADOWS KY	500 CLINTON	IA	(A)	1 THE MEADOWS KY
501 DAVENPORT	IA	(A)	1 THE MEADOWS KY	502 SHEBOYGAN	WI	(A)	1 THE MEADOWS KY
503 KENOSHA	WI	(A)	1 THE MEADOWS KY	504 MILWAUKEE	WI	(A)	1 THE MEADOWS KY
505 RACINE	WI	(A)	1 THE MEADOWS KY	506 JANESVILLE	WI	(A)	1 THE MEADOWS KY
507 MADISON	WI	(A)	1 THE MEADOWS KY	508 PLATTEVILLE	WI	(A)	1 THE MEADOWS KY
509 PORTAGE	WI	(A)	1 THE MEADOWS KY	510 RIVER FALLS	WI	(A)	1 THE MEADOWS KY
511 MARINETTE	WI	(A)	1 THE MEADOWS KY	512 MANITOWOC	WI	(A)	1 THE MEADOWS KY
513 GREEN BAY	WI	(A)	1 THE MEADOWS KY	514 WAUSAU	WI	(A)	1 THE MEADOWS KY
515 RHINELANDER	WI	(A)	1 THE MEADOWS KY	516 LA CROSSE	WI	(A)	1 THE MEADOWS KY
517 EAU CLAIRE	WI	(A)	1 THE MEADOWS KY	518 SPOONER	WI	(A)	1 THE MEADOWS KY
519 OSHKOSH	WI	(A)	1 THE MEADOWS KY	520 STILLWATER	MN	(A)	1 THE MEADOWS KY
521 SAINT PAUL	MN	(A)	1 THE MEADOWS KY	522 ANOKA	MN	(A)	1 THE MEADOWS KY
523 MINNEAPOLIS	MN	(A)	1 THE MEADOWS KY	526 HIBBING	MN	(A)	1 THE MEADOWS KY
527 DULUTH	MN	(A)	1 THE MEADOWS KY	528 ROCHESTER	MN	(A)	1 THE MEADOWS KY
529 MANKATO	MN	(A)	1 THE MEADOWS KY	530 WINDOM	MN	(A)	1 THE MEADOWS KY
531 WILLMAR	MN	(A)	1 THE MEADOWS KY	532 SAINT CLOUD	MN	(A)	1 THE MEADOWS KY
533 BRAINERD	MN	(A)	1 THE MEADOWS KY	534 DETROIT LAKES	MN	(A)	1 THE MEADOWS KY
535 BEMIDJI	MN	(A)	1 THE MEADOWS KY	536 THIEF RIVER F	MN	(A)	1 THE MEADOWS KY
537 BROOKINGS	SD	(A)	1 THE MEADOWS KY	538 SIOUX FALLS	SD	(A)	1 THE MEADOWS KY
539 WATERTOWN	SD	(A)	1 THE MEADOWS KY	540 MITCHELL	SD	(A)	1 THE MEADOWS KY
541 ABERDEEN	SD	(A)	1 THE MEADOWS KY	542 PIERRE	SD	(A)	1 THE MEADOWS KY
544 RAPID CITY	SD	(A)	1 THE MEADOWS KY	545 WAHPETON	ND	(A)	1 THE MEADOWS KY
546 FARGO	ND	(A)	1 THE MEADOWS KY	547 GRAND FORKS	ND	(A)	1 THE MEADOWS KY
548 DEVILS LAKE	ND	(A)	1 THE MEADOWS KY	549 JAMESTOWN	ND	(A)	1 THE MEADOWS KY
550 BISMARCK	ND	(A)	1 THE MEADOWS KY	551 DICKINSON	ND	(A)	1 THE MEADOWS KY
552 MINOT	ND	(A)	1 THE MEADOWS KY	553 WILLISTON	ND	(A)	1 THE MEADOWS KY
554 LIVINGSTON	MT	(C)	3 ONTARIO INTERNCA	555 BILLINGS	MT	(C)	3 ONTARIO INTERNCA
556 WOLF POINT	MT	(A)	1 THE MEADOWS KY	557 MILES CITY	MT	(A)	1 THE MEADOWS KY
558 GREAT FALLS	MT	(C)	3 ONTARIO INTERNCA	559 HAVRE	MT	(C)	3 ONTARIO INTERNCA
560 HELENA	MT	(C)	3 ONTARIO INTERNCA	561 BUTTE	MT	(C)	3 ONTARIO INTERNCA
562 MISSOULA	MT	(C)	3 ONTARIO INTERNCA	563 KALISPELL	MT	(C)	3 ONTARIO INTERNCA
564 ARLINGTON HTS	IL	(A)	1 THE MEADOWS KY	565 ELGIN	IL	(A)	1 THE MEADOWS KY
566 EVANSTON	IL	(A)	1 THE MEADOWS KY	568 JOLIET	IL	(A)	1 THE MEADOWS KY
569 NAPERVILLE	IL	(A)	1 THE MEADOWS KY	570 CHICAGO	IL	(A)	1 THE MEADOWS KY
571 NILES	IL	(A)	1 THE MEADOWS KY	572 MORTON PARK	IL	(A)	1 THE MEADOWS KY
573 KANKAKEE	IL	(A)	1 THE MEADOWS KY	574 FREEPORT	IL	(A)	1 THE MEADOWS KY

CUSTOMER ASSIGNMENT MAP KEY

SAILS: REL 99-1C
22 APRL 0
osnew1

CUSTOMER CLASS : 1 STD CUSTCLASS   PRODUCT BUNDLE : 1 STD PRD BUNDLE

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT		CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	
575 ROCKFORD	IL	(A)	1 THE MEADOWS	KY	576 ROCK ISLAND	IL	(A)	1 THE MEADOWS	KY
577 LA SALLE	IL	(A)	1 THE MEADOWS	KY	578 GALESBURG	IL	(A)	1 THE MEADOWS	KY
579 PEKIN	IL	(A)	1 THE MEADOWS	KY	580 PEORIA	IL	(A)	1 THE MEADOWS	KY
581 BLOOMINGTON	IL	(A)	1 THE MEADOWS	KY	582 CHAMPAIGN	IL	(A)	1 THE MEADOWS	KY
583 CHARLESTON	IL	(A)	1 THE MEADOWS	KY	584 GRANITE CITY	IL	(A)	1 THE MEADOWS	KY
585 EAST ST LOUIS	IL	(A)	1 THE MEADOWS	KY	586 QUINCY	IL	(A)	1 THE MEADOWS	KY
587 EFFINGHAM	IL	(A)	1 THE MEADOWS	KY	588 DECATUR	IL	(A)	1 THE MEADOWS	KY
589 JACKSONVILLE	IL	(A)	1 THE MEADOWS	KY	590 SPRINGFIELD	IL	(A)	1 THE MEADOWS	KY
591 CENTRALIA	IL	(A)	1 THE MEADOWS	KY	592 CARBONDALE	IL	(A)	1 THE MEADOWS	KY
593 FLORISSANT	IL	(A)	1 THE MEADOWS	KY	594 SAINT LOUIS	MO	(A)	1 THE MEADOWS	KY
595 SAINT CHARLES	MO	(A)	1 THE MEADOWS	KY	596 HANNIBAL	MO	(A)	1 THE MEADOWS	KY
597 KIRKSVILLE	MO	(A)	1 THE MEADOWS	KY	598 FLAT RIVER	MO	(A)	1 THE MEADOWS	KY
599 CAPE GIRARDEA	MO	(A)	1 THE MEADOWS	KY	600 SIKESTON	MO	(A)	1 THE MEADOWS	KY
601 POPLAR BLUFF	MO	(A)	1 THE MEADOWS	KY	602 INDEPENDENCE	MO	(A)	1 THE MEADOWS	KY
603 KANSAS CITY	MO	(A)	1 THE MEADOWS	KY	604 MARYVILLE	MO	(A)	1 THE MEADOWS	KY
605 SAINT JOSEPH	MO	(A)	1 THE MEADOWS	KY	606 CHILLICOTHE	MO	(A)	1 THE MEADOWS	KY
607 HARRISONVILLE	MO	(A)	1 THE MEADOWS	KY	608 JOPLIN	MO	(A)	1 THE MEADOWS	KY
610 ELDON	MO	(A)	1 THE MEADOWS	KY	611 JEFFERSON CTY	MO	(A)	1 THE MEADOWS	KY
612 COLUMBIA	MO	(A)	1 THE MEADOWS	KY	613 SEDALIA	MO	(A)	1 THE MEADOWS	KY
614 ROLLA	MO	(A)	1 THE MEADOWS	KY	615 LEBANON	MO	(A)	1 THE MEADOWS	KY
616 AURORA	MO	(A)	1 THE MEADOWS	KY	617 WEST PLAINS	MO	(A)	1 THE MEADOWS	KY
618 SPRINGFIELD	MO	(A)	1 THE MEADOWS	KY	619 LAWRENCE	KS	(A)	1 THE MEADOWS	KY
620 KANSAS CITY	KS	(A)	1 THE MEADOWS	KY	621 SHAWNEE MISSI	KS	(A)	1 THE MEADOWS	KY
622 JUNCTION CITY	KS	(A)	1 THE MEADOWS	KY	623 MANHATTAN	KS	(A)	1 THE MEADOWS	KY
624 TOPEKA	KS	(A)	1 THE MEADOWS	KY	625 FORT SCOTT	KS	(A)	1 THE MEADOWS	KY
626 EMPORIA	KS	(A)	1 THE MEADOWS	KY	628 ARKANSAS CITY	KS	(A)	1 THE MEADOWS	KY
629 NEWTON	KS	(A)	1 THE MEADOWS	KY	630 WICHITA	KS	(A)	1 THE MEADOWS	KY
631 INDEPENDENCE	KS	(A)	1 THE MEADOWS	KY	632 SALINA	KS	(A)	1 THE MEADOWS	KY
633 HUTCHINSON	KS	(A)	1 THE MEADOWS	KY	634 HAYS	KS	(A)	1 THE MEADOWS	KY
635 COLBY	KS	(A)	1 THE MEADOWS	KY	636 DODGE CITY	KS	(A)	1 THE MEADOWS	KY
637 LIBERAL	KS	(A)	1 THE MEADOWS	KY	638 FREMONT	NE	(A)	1 THE MEADOWS	KY
639 OMAHA	NE	(A)	1 THE MEADOWS	KY	640 BEATRICE	NE	(A)	1 THE MEADOWS	KY
641 YORK	NE	(A)	1 THE MEADOWS	KY	642 LINCOLN	NE	(A)	1 THE MEADOWS	KY
643 COLUMBUS	NE	(A)	1 THE MEADOWS	KY	644 NORFOLK	NE	(A)	1 THE MEADOWS	KY
645 GRAND ISLAND	NE	(A)	1 THE MEADOWS	KY	646 HASTINGS	NE	(A)	1 THE MEADOWS	KY
647 MCCOOK	NE	(A)	1 THE MEADOWS	KY	648 NORTH PLATTE	NE	(A)	1 THE MEADOWS	KY
650 ALLIANCE	NE	(A)	1 THE MEADOWS	KY	651 METARIE	LA	(A)	1 THE MEADOWS	KY
652 NEW ORLEANS	LA	(A)	1 THE MEADOWS	KY	653 THIBODAUX	LA	(A)	1 THE MEADOWS	KY
654 HAMMOND	LA	(A)	1 THE MEADOWS	KY	655 LAFAYETTE	LA	(A)	1 THE MEADOWS	KY
656 LAKE CHARLES	LA	(A)	1 THE MEADOWS	KY	657 BAKER	LA	(A)	1 THE MEADOWS	KY
658 BATON ROUGE	LA	(A)	1 THE MEADOWS	KY	659 MINDEN	LA	(A)	1 THE MEADOWS	KY
660 SHREVEPORT	LA	(A)	1 THE MEADOWS	KY	661 MONROE	LA	(A)	1 THE MEADOWS	KY
662 ALEXANDRIA	LA	(A)	1 THE MEADOWS	KY	663 NATCHITOCHES	LA	(A)	1 THE MEADOWS	KY
664 PINE BLUFF	AR	(A)	1 THE MEADOWS	KY	665 CAMDEN	AR	(A)	1 THE MEADOWS	KY
666 HOPE	AR	(A)	1 THE MEADOWS	KY	667 HOT SPRINGS N	AR	(A)	1 THE MEADOWS	KY
668 JACKSONVILLE	AR	(A)	1 THE MEADOWS	KY	669 NORTH LITTLE R	AR	(A)	1 THE MEADOWS	KY
670 LITTLE ROCK	AR	(A)	1 THE MEADOWS	KY	671 WEST MEMPHIS	AR	(A)	1 THE MEADOWS	KY

CUSTOMER ASSIGNMENT MAP KEY

CUSTOMER CLASS : 1 STD CUSTCLASS PRODUCT BUNDLE : 1 STD PRD BUNDLE

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	CUSTOMER REGION		SYMBOL	DC ASSIGNMENT
672 JONESBORO	AR	(A)	1 THE MEADOWS KY	673 BATESVILLE	AR	(A)	1 THE MEADOWS KY
674 HARRISON	AR	(A)	1 THE MEADOWS KY	675 FAYETTEVILLE	AR	(A)	1 THE MEADOWS KY
676 RUSSELLVILLE	AR	(A)	1 THE MEADOWS KY	677 FORT SMITH	AR	(A)	1 THE MEADOWS KY
678 NORMAN	OK	(A)	1 THE MEADOWS KY	679 OKLAHOMA CITY	OK	(A)	1 THE MEADOWS KY
681 ARDMORE	OK	(A)	1 THE MEADOWS KY	682 LAWTON	OK	(A)	1 THE MEADOWS KY
683 CLINTON	OK	(A)	1 THE MEADOWS KY	684 ENID	OK	(A)	1 THE MEADOWS KY
686 GUYMAN	OK	(A)	1 THE MEADOWS KY	687 STILLWATER	OK	(A)	1 THE MEADOWS KY
688 TULSA	OK	(A)	1 THE MEADOWS KY	689 MIAMI	OK	(A)	1 THE MEADOWS KY
690 MUSKOGEE	OK	(A)	1 THE MEADOWS KY	691 MCALESTER	OK	(A)	1 THE MEADOWS KY
692 PONCA CITY	OK	(A)	1 THE MEADOWS KY	693 DURANT	OK	(A)	1 THE MEADOWS KY
694 SHAWNEE	OK	(A)	1 THE MEADOWS KY	695 POTEAU	OK	(A)	1 THE MEADOWS KY
696 GARLAND	TX	(A)	1 THE MEADOWS KY	697 MESQUITE	TX	(A)	1 THE MEADOWS KY
698 DALLAS	TX	(A)	1 THE MEADOWS KY	699 JUANITA CRAFT	TX	(A)	1 THE MEADOWS KY
700 GREENVILLE	TX	(A)	1 THE MEADOWS KY	701 TEXARKANA	TX	(A)	1 THE MEADOWS KY
702 LONGVIEW	TX	(A)	1 THE MEADOWS KY	703 TYLER	TX	(A)	1 THE MEADOWS KY
704 PALESTINE	TX	(A)	1 THE MEADOWS KY	705 LUFKIN	TX	(A)	1 THE MEADOWS KY
706 ARLINGTON	TX	(A)	1 THE MEADOWS KY	707 FORT WORTH	TX	(A)	1 THE MEADOWS KY
708 DENTON	TX	(A)	1 THE MEADOWS KY	709 WICHITA FALLS	TX	(A)	1 THE MEADOWS KY
710 STEPHENVILLE	TX	(A)	1 THE MEADOWS KY	711 TEMPLE	TX	(A)	1 THE MEADOWS KY
712 HILLSBORO	TX	(A)	1 THE MEADOWS KY	713 WACO	TX	(A)	1 THE MEADOWS KY
714 BROWNWOOD	TX	(A)	1 THE MEADOWS KY	715 SAN ANGELO	TX	(A)	1 THE MEADOWS KY
716 HOUSTON	TX	(A)	1 THE MEADOWS KY	718 HOUSTON INTERNTX		(A)	1 THE MEADOWS KY
719 CONROE	TX	(A)	1 THE MEADOWS KY	720 MISSOURI CITY	TX	(A)	1 THE MEADOWS KY
721 PASADENA	TX	(A)	1 THE MEADOWS KY	722 PORT ARTHUR	TX	(A)	1 THE MEADOWS KY
723 BEAUMONT	TX	(A)	1 THE MEADOWS KY	724 BRYAN	TX	(A)	1 THE MEADOWS KY
725 VICTORIA	TX	(A)	1 THE MEADOWS KY	726 LAREDO	TX	(A)	1 THE MEADOWS KY
727 NEW BRAUNFELS	TX	(A)	1 THE MEADOWS KY	728 SAN ANTONIO	TX	(A)	1 THE MEADOWS KY
729 KINGSVILLE	TX	(A)	1 THE MEADOWS KY	730 CORPUS CHRIST	TX	(A)	1 THE MEADOWS KY
731 MC ALLEN	TX	(A)	1 THE MEADOWS KY	732 SAN MARCOS	TX	(A)	1 THE MEADOWS KY
733 AUSTIN	TX	(A)	1 THE MEADOWS KY	734 DEL RIO	TX	(A)	1 THE MEADOWS KY
735 GIDDINGS	TX	(A)	1 THE MEADOWS KY	736 PLAINVIEW	TX	(A)	1 THE MEADOWS KY
737 AMARILLO	TX	(A)	1 THE MEADOWS KY	738 CHILDRESS	TX	(A)	1 THE MEADOWS KY
739 LEVELLAND	TX	(A)	1 THE MEADOWS KY	740 LUBBOCK	TX	(A)	1 THE MEADOWS KY
741 SNYDER	TX	(A)	1 THE MEADOWS KY	742 ABILENE	TX	(A)	1 THE MEADOWS KY
743 MIDLAND	TX	(A)	1 THE MEADOWS KY	745 EL PASO	TX	(A)	1 THE MEADOWS KY
746 AURORA	CO	(A)	1 THE MEADOWS KY	747 ENGLEWOOD	CO	(A)	1 THE MEADOWS KY
748 DENVER	CO	(A)	1 THE MEADOWS KY	749 BOULDER	CO	(A)	1 THE MEADOWS KY
750 GOLDEN	CO	(A)	1 THE MEADOWS KY	751 LONGMONT	CO	(A)	1 THE MEADOWS KY
752 BRIGHTON	CO	(A)	1 THE MEADOWS KY	753 STERLING	CO	(A)	1 THE MEADOWS KY
754 USAF ACADEMY	CO	(A)	1 THE MEADOWS KY	755 COLORADO SPRI	CO	(A)	1 THE MEADOWS KY
756 PUEBLO	CO	(A)	1 THE MEADOWS KY	757 ALAMOSA	CO	(A)	1 THE MEADOWS KY
758 SALIDA	CO	(A)	1 THE MEADOWS KY	759 DURANGO	CO	(A)	1 THE MEADOWS KY
760 MONTROSE	CO	(A)	1 THE MEADOWS KY	761 GRAND JUNCTIO	CO	(A)	1 THE MEADOWS KY
762 GLENWOOD SPRI	CO	(C)	3 ONTARIO INTERNCA	763 CHEYENNE	WY	(A)	1 THE MEADOWS KY
765 WHEATLAND	WY	(A)	1 THE MEADOWS KY	767 WORLAND	WY	(C)	3 ONTARIO INTERNCA
768 RIVERTON	WY	(C)	3 ONTARIO INTERNCA	769 CASPER	WY	(A)	1 THE MEADOWS KY
770 GILLETTE	WY	(A)	1 THE MEADOWS KY	771 SHERIDAN	WY	(A)	1 THE MEADOWS KY

CUSTOMER ASSIGNMENT MAP KEY

CUSTOMER CLASS : 1 STD CUSTCLASS   PRODUCT BUNDLE : 1 STD PRD BUNDLE

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	CUSTOMER REGION		SYMBOL	DC ASSIGNMENT
772 ROCK SPRINGS	WY	(A)	1 THE MEADOWS KY	773 JACKSON	WY	(C)	3 ONTARIO INTERNCA
774 KEMMERER	WY	(C)	3 ONTARIO INTERNCA	775 POCATELLO	ID	(C)	3 ONTARIO INTERNCA
776 TWIN FALLS	ID	(C)	3 ONTARIO INTERNCA	777 IDAHO FALLS	ID	(C)	3 ONTARIO INTERNCA
778 LEWISTON	ID	(C)	3 ONTARIO INTERNCA	779 NAMPA	ID	(C)	3 ONTARIO INTERNCA
780 BOISE	ID	(C)	3 ONTARIO INTERNCA	781 COEUR d'ALENE	ID	(C)	3 ONTARIO INTERNCA
782 OREM	UT	(C)	3 ONTARIO INTERNCA	783 SALT LAKE CIT	UT	(C)	3 ONTARIO INTERNCA
785 LOGAN	UT	(C)	3 ONTARIO INTERNCA	786 OGDEN	UT	(C)	3 ONTARIO INTERNCA
787 PRICE	UT	(C)	3 ONTARIO INTERNCA	788 PROVO	UT	(C)	3 ONTARIO INTERNCA
789 ST GEORGE	UT	(C)	3 ONTARIO INTERNCA	790 PHOENIX	AZ	(C)	3 ONTARIO INTERNCA
791 MESA	AZ	(C)	3 ONTARIO INTERNCA	792 GLENDALE	AZ	(C)	3 ONTARIO INTERNCA
793 GLOBE	AZ	(C)	3 ONTARIO INTERNCA	794 SIERRA VISTA	AZ	(C)	3 ONTARIO INTERNCA
795 TUCSON	AZ	(C)	3 ONTARIO INTERNCA	797 FLAGSTAFF	AZ	(C)	3 ONTARIO INTERNCA
798 PRESCOTT	AZ	(C)	3 ONTARIO INTERNCA	799 KINGMAN	AZ	(C)	3 ONTARIO INTERNCA
801 GRANTS	NM	(A)	1 THE MEADOWS KY	802 ALBUQUERQUE	NM	(A)	1 THE MEADOWS KY
804 GALLUP	NM	(C)	3 ONTARIO INTERNCA	805 FARMINGTON	NM	(C)	3 ONTARIO INTERNCA
806 SANTA FE	NM	(A)	1 THE MEADOWS KY	808 SOCORRO	NM	(A)	1 THE MEADOWS KY
809 TRUTH OR CONS	NM	(A)	1 THE MEADOWS KY	810 LAS CRUCES	NM	(C)	3 ONTARIO INTERNCA
811 CLOVIS	NM	(A)	1 THE MEADOWS KY	812 ROSWELL	NM	(A)	1 THE MEADOWS KY
813 CARRIZOZO	NM	(A)	1 THE MEADOWS KY	817 NORTH LAS VEGANV		(C)	3 ONTARIO INTERNCA
818 LAS VEGAS	NV	(C)	3 ONTARIO INTERNCA	819 ELY	NV	(C)	3 ONTARIO INTERNCA
820 FALLON	NV	(C)	3 ONTARIO INTERNCA	821 RENO	NV	(C)	3 ONTARIO INTERNCA
822 CARSON CITY	NV	(C)	3 ONTARIO INTERNCA	823 ELKO	NV	(C)	3 ONTARIO INTERNCA
824 LOS ANGELES	CA	(C)	3 ONTARIO INTERNCA	826 DOWNEY	CA	(C)	3 ONTARIO INTERNCA
827 INGLEWOOD	CA	(C)	3 ONTARIO INTERNCA	828 SANTA MONICA	CA	(C)	3 ONTARIO INTERNCA
829 TORRANCE	CA	(C)	3 ONTARIO INTERNCA	830 NORWALK	CA	(C)	3 ONTARIO INTERNCA
831 CARSON	CA	(C)	3 ONTARIO INTERNCA	832 LONG BEACH	CA	(C)	3 ONTARIO INTERNCA
833 ARCADIA	CA	(C)	3 ONTARIO INTERNCA	834 PASADENA	CA	(C)	3 ONTARIO INTERNCA
835 GLENDALE	CA	(C)	3 ONTARIO INTERNCA	836 THOUSAND OAKS	CA	(C)	3 ONTARIO INTERNCA
837 VAN NUYS	CA	(C)	3 ONTARIO INTERNCA	838 BURBANK	CA	(C)	3 ONTARIO INTERNCA
839 NORTH HOLLYWO	CA	(C)	3 ONTARIO INTERNCA	840 POMONA	CA	(C)	3 ONTARIO INTERNCA
841 ALHAMBRA	CA	(C)	3 ONTARIO INTERNCA	842 CHULA VISTA	CA	(C)	3 ONTARIO INTERNCA
843 OCEANSIDE	CA	(C)	3 ONTARIO INTERNCA	844 SAN DIEGO	CA	(C)	3 ONTARIO INTERNCA
845 PALM SPRINGS	CA	(C)	3 ONTARIO INTERNCA	846 REDLANDS	CA	(C)	3 ONTARIO INTERNCA
847 SAN BERNARDIN	CA	(C)	3 ONTARIO INTERNCA	848 RIVERSIDE	CA	(C)	3 ONTARIO INTERNCA
849 HUNTINGTON BEACA		(C)	3 ONTARIO INTERNCA	850 SANTA ANA	CA	(C)	3 ONTARIO INTERNCA
851 ANAHEIM	CA	(C)	3 ONTARIO INTERNCA	852 OXNARD	CA	(C)	3 ONTARIO INTERNCA
853 SANTA BARBARA	CA	(C)	3 ONTARIO INTERNCA	854 VISALIA	CA	(C)	3 ONTARIO INTERNCA
855 BAKERSFIELD	CA	(C)	3 ONTARIO INTERNCA	856 SANTA MARIA	CA	(C)	3 ONTARIO INTERNCA
857 MOJAVE	CA	(C)	3 ONTARIO INTERNCA	858 CLOVIS	CA	(C)	3 ONTARIO INTERNCA
859 FRESNO	CA	(C)	3 ONTARIO INTERNCA	861 SALINAS	CA	(C)	3 ONTARIO INTERNCA
862 SUNNYVALE	CA	(C)	3 ONTARIO INTERNCA	863 SAN FRANCISCO	CA	(C)	3 ONTARIO INTERNCA
864 SACRAMENTO	CA	(C)	3 ONTARIO INTERNCA	865 PALO ALTO	CA	(C)	3 ONTARIO INTERNCA
866 SAN MATEO	CA	(C)	3 ONTARIO INTERNCA	867 FREMONT	CA	(C)	3 ONTARIO INTERNCA
868 OAKLAND	CA	(C)	3 ONTARIO INTERNCA	869 BERKLEY	CA	(C)	3 ONTARIO INTERNCA
870 RICHMOND	CA	(C)	3 ONTARIO INTERNCA	871 NORTH BAY	CA	(C)	3 ONTARIO INTERNCA
872 SANTA CRUZ	CA	(C)	3 ONTARIO INTERNCA	873 SAN JOSE	CA	(C)	3 ONTARIO INTERNCA
874 STOCKTON	CA	(C)	3 ONTARIO INTERNCA	875 MODESTO	CA	(C)	3 ONTARIO INTERNCA

CUSTOMER ASSIGNMENT MAP KEY

SAILS: REL 99-1C
22 APRL 0
osnew1

CUSTOMER CLASS : 1 STD CUSTCLASS

PRODUCT BUNDLE : 1 STD PRD BUNDLE

CUSTOMER REGION		SYMBOL	DC ASSIGNMENT	CUSTOMER REGION		SYMBOL	DC ASSIGNMENT
876 SANTA ROSA	CA	(C)	3 ONTARIO INTERNCA	877 EUREKA	CA	(C)	3 ONTARIO INTERNCA
878 CITRUS HEIGHTS	CA	(C)	3 ONTARIO INTERNCA	879 RANCHO CORDOVA	CA	(C)	3 ONTARIO INTERNCA
880 SACRAMENTO	CA	(C)	3 ONTARIO INTERNCA	881 MARYSVILLE	CA	(C)	3 ONTARIO INTERNCA
882 REDDING	CA	(C)	3 ONTARIO INTERNCA	883 SOUTH LAKE TAH	CA	(C)	3 ONTARIO INTERNCA
887 GRESHAM	OR	(C)	3 ONTARIO INTERNCA	888 HILLSBORO	OR	(C)	3 ONTARIO INTERNCA
889 PORTLAND	OR	(C)	3 ONTARIO INTERNCA	890 SALEM	OR	(C)	3 ONTARIO INTERNCA
891 EUGENE	OR	(C)	3 ONTARIO INTERNCA	892 MEDFORD	OR	(C)	3 ONTARIO INTERNCA
893 KLAMATH FALLS	OR	(C)	3 ONTARIO INTERNCA	894 BEND	OR	(C)	3 ONTARIO INTERNCA
895 PENDLETON	OR	(C)	3 ONTARIO INTERNCA	896 ONTARIO	OR	(C)	3 ONTARIO INTERNCA
897 BELLEVUE	WA	(C)	3 ONTARIO INTERNCA	898 SEATTLE	WA	(C)	3 ONTARIO INTERNCA
899 EVERETT	WA	(C)	3 ONTARIO INTERNCA	900 BREMERTON	WA	(C)	3 ONTARIO INTERNCA
901 TACOMA	WA	(C)	3 ONTARIO INTERNCA	902 OLYMPIA	WA	(C)	3 ONTARIO INTERNCA
903 VANCOUVER	WA	(C)	3 ONTARIO INTERNCA	904 WENATCHEE	WA	(C)	3 ONTARIO INTERNCA
905 YAKIMA	WA	(C)	3 ONTARIO INTERNCA	906 CHENEY	WA	(C)	3 ONTARIO INTERNCA
907 PULLMAN	WA	(C)	3 ONTARIO INTERNCA	908 SPOKANE	WA	(C)	3 ONTARIO INTERNCA
909 PASCO	WA	(C)	3 ONTARIO INTERNCA	910 CLARKSTON	WA	(C)	3 ONTARIO INTERNCA

Appendix-2


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                 44-I
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                 42-I
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                 40-I
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                 38-I
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                 36-I
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                 34-I
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                 32-I                           XXXXXXXX
                   -I                           XXXXXXXX
                 30-I                           XXXXXXXX
                   -I                           XXXXXXXX
    PERCENT      28-I                           XXXXXXXX
                   -I                           XXXXXXXX
       OF        26-I                           XXXXXXXX
                   -I                           XXXXXXXX
     TOTAL       24-I                           XXXXXXXX XXXXXXXX
                   -I                           XXXXXXXX XXXXXXXX
     DEMAND      22-I                           XXXXXXXX XXXXXXXX
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                 20-I                           XXXXXXXX XXXXXXXX
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                 18-I                           XXXXXXXX XXXXXXXX XXXXXXXX
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                 16-I                           XXXXXXXX XXXXXXXX XXXXXXXX
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                  6-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
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                  4-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
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                  2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                  0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->   0        50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        5.08     3.33     8.19    32.16    24.18    18.49     8.57     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:   31.06    66.13   163.44   381.66   620.60   843.66  1137.68     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:  543.45
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DISTRIBUTION CTR: 1 THE MEADOWS KY

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                              -I
                            48-I
                              -I
                            46-I
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                            44-I
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                            42-I
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                            36-I
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                            34-I
                              -I                            XXXXXXXX
                            32-I                            XXXXXXXX
                              -I                            XXXXXXXX
                            30-I                            XXXXXXXX
                              -I                            XXXXXXXX
                PERCENT     28-I                            XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX
                   OF       26-I                            XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX
                 TOTAL      24-I                            XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX
                 DEMAND     22-I                            XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            20-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            18-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            16-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            14-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                              -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            12-I                            XXXXXXXX XXXXXXXX XXXXXXXX
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                            10-I                            XXXXXXXX XXXXXXXX XXXXXXXX
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                             8-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                              -I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                             6-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                              -I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                             4-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
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                             2-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                              -I          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                             0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->              0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:                0.27     1.42     8.50    33.27    28.97    21.17     6.41     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:           11.38    79.09   165.33   379.88   618.32   838.43  1135.54     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:         570.92
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                        100-I
                           -I
                         96-I
                           -I
                         92-I
                           -I
                         88-I
                           -I
                         84-I
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                         80-I
                           -I
                         76-I
                           -I
                         72-I
                           -I
                         68-I
                           -I
                         64-I
                           -I
                         60-I
                           -I
             PERCENT     56-I         XXXXXXXX
                           -I         XXXXXXXX
                OF       52-I         XXXXXXXX
                           -I         XXXXXXXX
               TOTAL     48-I         XXXXXXXX
                           -I         XXXXXXXX
               DEMAND    44-I         XXXXXXXX
                           -I         XXXXXXXX
                         40-I         XXXXXXXX
                           -I         XXXXXXXX XXXXXXXX
                         36-I         XXXXXXXX XXXXXXXX
                           -I         XXXXXXXX XXXXXXXX
                         32-I         XXXXXXXX XXXXXXXX
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                          4-IXXXXXXXX XXXXXXXX XXXXXXXX
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                          0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->           0        50       100      250      500      750      1000     1500     2000     3000     99999

INTERVAL PERCENTAGES:               4.80     56.38     38.79     0.04      0.00      0.00      0.00      0.00      0.00      0.00
DEMAND-WEIGHTED AVERAGES:          25.17     56.18    155.81   287.00      0.00      0.00      0.00      0.00      0.00      0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:          93.41
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            50-I
              -I
            48-I
              -I
            46-I
              -I
            44-I
              -I
            42-I
              -I
            40-I
              -I
            38-I
              -I
            36-I
              -I
            34-I
              -I
            32-I
              -I
            30-I                           XXXXXXXX
              -I                           XXXXXXXX
PERCENT     28-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
  OF        26-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
 TOTAL      24-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
 DEMAND     22-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
            20-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            18-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            16-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            14-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            12-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            10-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
             8-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX          XXXXXXXX XXXXXXXX
             6-IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
              -IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
             4-IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
              -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
             2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
              -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
             0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->  0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        28.46     6.63     3.25    30.41     3.64     7.61    20.00     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:    32.07    62.16   149.67   391.16   708.76   914.25  1140.99     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:      460.62
```

Appendix-3

```
SOLVER REPORTS                       SYSTEMWIDE CUSTOMER SERVICE HISTOGRAM PLOT                     SAILS: REL 99-1C
PAGE   41                                                                                           os7ftl
                46-I
                  -I
                44-I
                  -I
                42-I
                  -I
                40-I
                  -I
                38-I
                  -I
                36-I
                  -I
                34-I
                  -I
                32-I
                  -I
                30-I                           XXXXXXXX
                  -I                           XXXXXXXX
    PERCENT     28-I                           XXXXXXXX
                  -I                           XXXXXXXX
       OF       26-I                           XXXXXXXX
                  -I                           XXXXXXXX
     TOTAL      24-I                           XXXXXXXX
                  -I                           XXXXXXXX
     DEMAND     22-I                           XXXXXXXX
                  -I                           XXXXXXXX
                20-I                  XXXXXXXX XXXXXXXX
                  -I                  XXXXXXXX XXXXXXXX
                18-I                  XXXXXXXX XXXXXXXX
                  -I                  XXXXXXXX XXXXXXXX
                16-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                14-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                12-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                10-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                 8-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX
                 6-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                 4-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                 2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                  -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                 0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->  0        50       100      250      500      750     1000     1500     2000     3000    99999
INTERVAL PERCENTAGES:    13.88     5.85    20.46    30.26    16.65     6.97     5.92     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:23.36    67.92   177.13   399.88   612.35   841.65  1163.84     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:      394.02
```

```
                                      DISTRIBUTION CTR:     1 BETHLEHEM-1802PA
                     100-I
                       -I
                     96-I
                       -I
                     92-I
                       -I
                     88-I
                       -I
                     84-I
                       -I
                     80-I
                       -I
                     76-I
                       -I
                     72-I
                       -I
                     68-I
                       -I
                     64-I
                       -I
                     60-I
                       -I
           PERCENT   56-I
                       -I         XXXXXXXX
              OF     52-I         XXXXXXXX
                       -I         XXXXXXXX
            TOTAL    48-I         XXXXXXXX
                       -I         XXXXXXXX
           DEMAND    44-I         XXXXXXXX
                       -I         XXXXXXXX
                     40-I         XXXXXXXX
                       -I         XXXXXXXX
                     36-I         XXXXXXXX
                       -I         XXXXXXXX
                     32-I         XXXXXXXX
                       -I         XXXXXXXX
                     28-I         XXXXXXXX
                       -I         XXXXXXXX
                     24-I         XXXXXXXX XXXXXXXX
                       -I         XXXXXXXX XXXXXXXX
                     20-I         XXXXXXXX XXXXXXXX
                       -IXXXXXXXX XXXXXXXX XXXXXXXX
                     16-IXXXXXXXX XXXXXXXX XXXXXXXX
                       -IXXXXXXXX XXXXXXXX XXXXXXXX
                     12-IXXXXXXXX XXXXXXXX XXXXXXXX
                       -IXXXXXXXX XXXXXXXX XXXXXXXX
                      8-IXXXXXXXX XXXXXXXX XXXXXXXX
                       -IXXXXXXXX XXXXXXXX XXXXXXXX
                      4-IXXXXXXXX XXXXXXXX XXXXXXXX
                       -IXXXXXXXX XXXXXXXX XXXXXXXX
                      0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->         0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:          19.38    54.52    25.04     1.06     0.00     0.00     0.00     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:       4.05    56.10   160.98   347.99     0.00     0.00     0.00     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:     75.36
```

```
SOLVER REPORTS                 CUSTOMER SERVICE HISTOGRAM PLOT BY DISTRIBUTION CTR                      SAILS: REL 99-1C
PAGE   43                           DISTRIBUTION CTR:    2 ONTARIO INTERNCA                             os7ftl
                        50-I
                          -I
                        48-I
                          -I
                        46-I
                          -I
                        44-I
                          -I
                        42-I
                          -I
                        40-I
                          -I
                        38-I
                          -I
                        36-I
                          -I
                        34-I
                          -I
                        32-I
                          -I
                        30-IXXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX
        PERCENT         28-IXXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX
          OF            26-IXXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX
         TOTAL          24-IXXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX
         DEMAND         22-IXXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX
                        20-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                        18-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                        16-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                        14-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                        12-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                        10-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                         8-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX XXXXXXXX          XXXXXXXX                   XXXXXXXX
                         6-IXXXXXXXX XXXXXXXX          XXXXXXXX                   XXXXXXXX
                          -IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
                         4-IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
                          -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX XXXXXXXX
                         2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX XXXXXXXX
                          -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                         0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->          0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:            30.76     7.16     3.52    30.82     1.27     5.54    20.93     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:        32.07    62.16   149.67   393.81   663.95   937.57  1137.20     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:       439.32
```

```
                      50-I
                        -I
                      48-I
                        -I
                      46-I
                        -I
                      44-I
                        -I
                      42-I
                        -I
                      40-I
                        -I
                      38-I
                        -I
                      36-I
                        -I
                      34-I
                        -I
                      32-I
                        -I
                      30-I                           XXXXXXXX
                        -I                           XXXXXXXX
          PERCENT     28-I                           XXXXXXXX
                        -I                           XXXXXXXX
             OF       26-I                  XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX
           TOTAL      24-I                  XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX
           DEMAND     22-I                  XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX
                      20-I                  XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX
                      18-I                  XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX
                      16-I                  XXXXXXXX XXXXXXXX          XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX          XXXXXXXX
                      14-I                  XXXXXXXX XXXXXXXX          XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX          XXXXXXXX
                      12-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                      10-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                       8-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                        -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                       6-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                        -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                       4-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                        -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                       2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                        -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                       0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->          0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:              6.74     6.66    26.24    30.23    12.07    16.87     1.19     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:         24.55    82.42   192.26   377.06   598.93   813.13  1182.10     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:       395.11
```

```
                  50-I
                    -I
                  48-I
                    -I
                  46-I
                    -I
                  44-I
                    -I
                  42-I
                    -I
                  40-I
                    -I
                  38-I
                    -I
                  36-I
                    -I
                  34-I
                    -I
                  32-I
                    -I
                  30-I                           XXXXXXXX
                    -I                           XXXXXXXX
       PERCENT    28-I                           XXXXXXXX
                    -I                           XXXXXXXX
          OF      26-IXXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX
         TOTAL    24-IXXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX
        DEMAND    22-IXXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX
                  20-IXXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX
                  18-IXXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX
                  16-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                  14-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                  12-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX XXXXXXXX          XXXXXXXX
                  10-IXXXXXXXX                   XXXXXXXX XXXXXXXX          XXXXXXXX
                    -IXXXXXXXX                   XXXXXXXX XXXXXXXX          XXXXXXXX
                   8-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                    -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                   6-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                    -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                   4-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->    0        50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        26.26     2.56     8.82    30.17    11.79     4.37    16.03     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:    18.46    72.38   156.50   424.37   636.68   939.48  1215.81     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:        459.55
```

CUSTOMER SERVICE HISTOGRAM PLOT BY DISTRIBUTION CTR

DISTRIBUTION CTR: 6 CARROLLTON-750TX

```
                50-I
                  -I
                48-I
                  -I
                46-IXXXXXXXX
                  -IXXXXXXXX
                44-IXXXXXXXX
                  -IXXXXXXXX
                42-IXXXXXXXX
                  -IXXXXXXXX
                40-IXXXXXXXX
                  -IXXXXXXXX
                38-IXXXXXXXX
                  -IXXXXXXXX
                36-IXXXXXXXX
                  -IXXXXXXXX
                34-IXXXXXXXX
                  -IXXXXXXXX
                32-IXXXXXXXX
                  -IXXXXXXXX
                30-IXXXXXXXX
                  -IXXXXXXXX
     PERCENT    28-IXXXXXXXX
                  -IXXXXXXXX
       OF       26-IXXXXXXXX
                  -IXXXXXXXX
      TOTAL     24-IXXXXXXXX
                  -IXXXXXXXX          XXXXXXXX
      DEMAND    22-IXXXXXXXX          XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX
                20-IXXXXXXXX          XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX
                18-IXXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX
                16-IXXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX
                14-IXXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX
                12-IXXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX
                10-IXXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX
                 8-IXXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX
                 6-IXXXXXXXX          XXXXXXXX XXXXXXXX                   XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX                   XXXXXXXX
                 4-IXXXXXXXX          XXXXXXXX XXXXXXXX                   XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                 2-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                  -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX
                 0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->  0       50      100      250      500      750     1000     1500     2000     3000    99999
```

	0	50	100	250	500	750	1000	1500	2000	3000
INTERVAL PERCENTAGES:	46.43	0.27	23.99	18.60	3.79	0.62	6.31	0.00	0.00	0.00
DEMAND-WEIGHTED AVERAGES:	17.91	85.14	175.31	370.40	633.33	911.62	1094.95	0.00	0.00	0.00

OVERALL DEMAND-WEIGHTED AVERAGE: 218.18

SOLVER REPORTS
REPORT #: 56-015
PAGE 47

CUSTOMER SERVICE HISTOGRAM PLOT BY DISTRIBUTION CTR

DISTRIBUTION CTR: 7 WESTLAND SHOPPOH

SAILS: REL 99-1C
22 APRL 0
os7ftl

```
                  50-I
                    -I
                  48-I
                    -I
                  46-I
                    -I
                  44-I
                    -I
                  42-I
                    -I
                  40-I
                    -I
                  38-I
                    -I
                  36-I
                    -I
                  34-I                           XXXXXXXX
                    -I                           XXXXXXXX
                  32-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  30-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
        PERCENT   28-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
          OF      26-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
         TOTAL    24-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
         DEMAND   22-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  20-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  18-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  16-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  14-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  12-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                  10-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                   8-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                   6-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                   4-I                  XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX
                   2-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->    0        50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:         2.29     1.61    26.45    34.84    32.19     2.56     0.06     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:    22.71    71.51   171.40   412.54   611.86   835.12  1167.27     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:  409.78
```

Appendix-4


```
                    -I
                  46-I
                    -I
                  44-I
                    -I
                  42-I
                    -I
                  40-I
                    -I
                  38-I
                    -I
                  36-I
                    -I
                  34-I
                    -I
                  32-I
                    -I                           XXXXXXXX
                  30-I                           XXXXXXXX
                    -I                           XXXXXXXX
     PERCENT      28-I                           XXXXXXXX
                    -I                           XXXXXXXX
       OF         26-I                           XXXXXXXX
                    -I                           XXXXXXXX
      TOTAL       24-I                           XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
      DEMAND      22-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  20-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  18-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                  16-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                  14-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                  12-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                  10-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   8-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   6-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   4-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->    0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:     5.29     3.35     8.19    31.85    23.53    18.06     9.73     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES: 30.04    66.07   163.44   381.97   618.31   843.24  1160.03     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:      549.49
```

DISTRIBUTION CTR: 1 THE MEADOWS   KY

osnew4

```
                          50-I
                            -I
                          48-I
                            -I
                          46-I
                            -I
                          44-I
                            -I
                          42-I
                            -I
                          40-I
                            -I
                          38-I
                            -I
                          36-I
                            -I
                          34-I
                            -I                            XXXXXXXX
                          32-I                            XXXXXXXX
                            -I                            XXXXXXXX
                          30-I                            XXXXXXXX
                            -I                            XXXXXXXX
               PERCENT    28-I                            XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX
                  OF      26-I                            XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX
                TOTAL     24-I                            XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX
                DEMAND    22-I                            XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                          20-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                          18-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                          16-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                          14-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                          12-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                          10-I                            XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                            XXXXXXXX XXXXXXXX XXXXXXXX
                           8-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           6-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           4-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           2-I                   XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->             0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:               0.27     1.42     8.53    33.36    28.77    21.23     6.42     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:          11.38    79.09   165.33   379.88   617.93   838.43  1135.55     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:       570.67
```

DISTRIBUTION CTR: 2 BETHLEHEM-1802PA

```
                  100-I
                     -I
                   96-I
                     -I
                   92-I
                     -I
                   88-I
                     -I
                   84-I
                     -I
                   80-I
                     -I
                   76-I
                     -I
                   72-I
                     -I
                   68-I
                     -I
                   64-I
                     -I
                   60-I
                     -I
         PERCENT   56-I          XXXXXXXX
                     -I          XXXXXXXX
            OF     52-I          XXXXXXXX
                     -I          XXXXXXXX
          TOTAL    48-I          XXXXXXXX
                     -I          XXXXXXXX
          DEMAND   44-I          XXXXXXXX
                     -I          XXXXXXXX
                   40-I          XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   36-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   32-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   28-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   24-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   20-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   16-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                   12-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                    8-I          XXXXXXXX XXXXXXXX
                     -I          XXXXXXXX XXXXXXXX
                    4-IXXXXXXXX XXXXXXXX XXXXXXXX
                     -IXXXXXXXX XXXXXXXX XXXXXXXX
                    0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->     0        50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:          4.80    56.38    38.79     0.04     0.00     0.00     0.00     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:     25.17    56.18   155.81   287.00     0.00     0.00     0.00     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:    93.41
```

DISTRIBUTION CTR: 3 ONTARIO INTERNCA

```
                50-I
                  -I
                48-I
                  -I
                46-I
                  -I
                44-I
                  -I
                42-I
                  -I
                40-I
                  -I
                38-I
                  -I
                36-I
                  -I
                34-I
                  -I
                32-I                           XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
                30-IXXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
PERCENT         28-IXXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
  OF            26-IXXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
 TOTAL          24-IXXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
 DEMAND         22-IXXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
                20-IXXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX
                18-IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                16-IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                14-IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                12-IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                10-IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                 8-IXXXXXXXX                  XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX XXXXXXXX          XXXXXXXX                  XXXXXXXX
                 6-IXXXXXXXX XXXXXXXX          XXXXXXXX                  XXXXXXXX
                  -IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
                 4-IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX XXXXXXXX
                 2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX XXXXXXXX
                  -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                 0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->  0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        31.99     7.45     3.66    32.05     1.32     5.30    18.22     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:    32.07    62.16   149.67   393.81   663.95   941.03  1136.77     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:       412.45
```

DISTRIBUTION CTR: 10 DES MOINES IA osnew4

```
             100-I
               -I
              96-I
               -I
              92-I
               -I
              88-I
               -I                                                      XXXXXXXX
              84-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              80-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              76-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              72-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              68-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              64-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              60-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
   PERCENT    56-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
     OF       52-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
    TOTAL     48-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
    DEMAND    44-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              40-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              36-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              32-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              28-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              24-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              20-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              16-I                                                      XXXXXXXX
               -I                                                      XXXXXXXX
              12-I                                                      XXXXXXXX
               -IXXXXXXXX                                              XXXXXXXX
               8-IXXXXXXXX                                              XXXXXXXX
               -IXXXXXXXX                                              XXXXXXXX
               4-IXXXXXXXX                                              XXXXXXXX
               -IXXXXXXXX                                     XXXXXXXX XXXXXXXX
               0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        10.24     0.94     0.00     0.02     0.01     2.59    86.19     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:     5.75    55.00   187.00   489.00   659.00   943.65  1266.22     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:     1117.13
```

Appendix-5

```
SOLVER REPORTS                     SYSTEMWIDE CUSTOMER SERVICE HISTOGRAM PLOT                      SAILS: REL 99-1C
PAGE   41                                                                                         osnew5
                  48-I
                    -I
                  46-I
                    -I
                  44-I
                    -I
                  42-I
                    -I
                  40-I
                    -I
                  38-I
                    -I
                  36-I
                    -I
                  34-I
                    -I
                  32-I                           XXXXXXXX
                    -I                           XXXXXXXX
                  30-I                           XXXXXXXX
                    -I                           XXXXXXXX
       PERCENT    28-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
          OF      26-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
        TOTAL     24-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
        DEMAND    22-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  20-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  18-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  16-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX
                  14-I                           XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                  12-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                  10-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                   8-I                           XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   6-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   4-IXXXXXXXX          XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                    -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                   0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->    0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        5.62     3.78     7.91    32.83    28.43    13.08     8.34     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:   29.28    67.49   163.46   380.95   625.35   838.25  1179.06     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:     528.02
```

SOLVER REPORTS — CUSTOMER SERVICE HISTOGRAM PLOT BY DISTRIBUTION CTR — SAILS: REL 99-1C

REPORT #: 56-015 — 24 APRL 0

PAGE 42 — DISTRIBUTION CTR: 1 THE MEADOWS KY — osnew5

```
                          50-I
                            -I
                          48-I
                            -I
                          46-I
                            -I
                          44-I
                            -I
                          42-I
                            -I
                          40-I
                            -I
                          38-I
                            -I                           XXXXXXXX
                          36-I                           XXXXXXXX
                            -I                           XXXXXXXX
                          34-I                           XXXXXXXX
                            -I                           XXXXXXXX
                          32-I                           XXXXXXXX
                            -I                           XXXXXXXX
                          30-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
              PERCENT     28-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
                 OF       26-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
               TOTAL      24-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
               DEMAND     22-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
                          20-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
                          18-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX
                          16-I                           XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                          14-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                          12-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                          10-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                           8-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           6-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           4-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           2-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                            -I         XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                           0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->            0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:             0.31     1.66     8.52    37.95    30.68    15.55     5.33     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:        11.38    79.09   162.41   379.45   617.51   829.58  1165.95     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:       539.81
```

```
                          100-I
                             -I
                           96-I
                             -I
                           92-I
                             -I
                           88-I
                             -I
                           84-I
                             -I
                           80-I
                             -I
                           76-I
                             -I
                           72-I
                             -I
                           68-I
                             -I
                           64-I
                             -I
                           60-I
                             -I
                PERCENT    56-I         XXXXXXXX
                             -I         XXXXXXXX
                   OF      52-I         XXXXXXXX
                             -I         XXXXXXXX
                 TOTAL     48-I         XXXXXXXX
                             -I         XXXXXXXX
                 DEMAND    44-I         XXXXXXXX
                             -I         XXXXXXXX
                           40-I         XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           36-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           32-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           28-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           24-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           20-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           16-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                           12-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                            8-I         XXXXXXXX XXXXXXXX
                             -I         XXXXXXXX XXXXXXXX
                            4-IXXXXXXXX XXXXXXXX XXXXXXXX
                             -IXXXXXXXX XXXXXXXX XXXXXXXX
                            0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->             0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:               4.80    56.38    38.79     0.04     0.00     0.00     0.00     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:          25.17    56.18   155.81   287.00     0.00     0.00     0.00     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:         93.41
```

24 APRL 0
osnew5

DISTRIBUTION CTR: 3 ONTARIO INTERNCA

```
            50-I
              -I
            48-I
              -I
            46-I
              -I
            44-I
              -I
            42-I
              -I
            40-I
              -I
            38-I
              -I
            36-I
              -I
            34-I
              -I
            32-I                           XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
            30-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
PERCENT     28-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
  OF        26-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
 TOTAL      24-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
 DEMAND     22-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
            20-IXXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX
            18-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            16-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            14-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            12-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
            10-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
             8-IXXXXXXXX                   XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX XXXXXXXX          XXXXXXXX                   XXXXXXXX
             6-IXXXXXXXX XXXXXXXX          XXXXXXXX                   XXXXXXXX
              -IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
             4-IXXXXXXXX XXXXXXXX          XXXXXXXX          XXXXXXXX XXXXXXXX
              -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX XXXXXXXX
             2-IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX          XXXXXXXX XXXXXXXX
              -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
             0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->  0       50       100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:        31.99     7.45     3.66    32.05     1.32     5.30    18.22     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:    32.07    62.16   149.67   393.81   663.95   941.03  1136.77     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:       412.45
```

DISTRIBUTION CTR: 8 NASHVILLE TN

```
                   100-I
                      -I
                    96-I
                      -I
                    92-I
                      -I
                    88-I
                      -I
                    84-I
                      -I
                    80-I
                      -I
                    76-I
                      -I
                    72-I
                      -I
                    68-I
                      -I
                    64-I
                      -I
                    60-I
                      -I                                    XXXXXXXX
          PERCENT   56-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
             OF     52-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
           TOTAL    48-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
          DEMAND    44-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    40-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    36-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    32-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    28-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    24-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    20-I                                    XXXXXXXX
                      -I                                    XXXXXXXX
                    16-I                                    XXXXXXXX
                      -I                           XXXXXXXX XXXXXXXX
                    12-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                      -I                           XXXXXXXX XXXXXXXX XXXXXXXX
                     8-I                           XXXXXXXX XXXXXXXX XXXXXXXX
                      -I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                     4-I                  XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                      -IXXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
                     0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->      0        50      100      250      500      750     1000     1500     2000     3000    99999
```

	0-50	50-100	100-250	250-500	500-750	750-1000	1000-1500	1500-2000	2000-3000	3000-99999
INTERVAL PERCENTAGES:	2.85	3.72	6.11	14.02	59.42	12.25	1.63	0.00	0.00	0.00
DEMAND-WEIGHTED AVERAGES:	17.10	78.57	190.80	367.53	648.63	843.04	1184.45	0.00	0.00	0.00

OVERALL DEMAND-WEIGHTED AVERAGE: 574.59

DISTRIBUTION CTR: 10 DES MOINES IA

```
                100-I
                   -I
                 96-I
                   -I
                 92-I
                   -I
                 88-I
                   -I
                 84-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 80-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 76-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 72-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 68-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 64-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 60-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
    PERCENT      56-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
       OF        52-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
     TOTAL       48-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
    DEMAND       44-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 40-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 36-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 32-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 28-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 24-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 20-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 16-I                                                      XXXXXXXX
                   -I                                                      XXXXXXXX
                 12-I                                                      XXXXXXXX
                   -IXXXXXXXX                                              XXXXXXXX
                  8-IXXXXXXXX                                              XXXXXXXX
                   -IXXXXXXXX                                              XXXXXXXX
                  4-IXXXXXXXX                                              XXXXXXXX
                   -IXXXXXXXX                                     XXXXXXXX XXXXXXXX
                  0-+--------+--------+--------+--------+--------+--------+--------+--------+--------+--------+
MILEAGE RANGES-->   0       50      100      250      500      750     1000     1500     2000     3000    99999

INTERVAL PERCENTAGES:       10.67     0.98     0.00     0.02     0.01     2.36    85.95     0.00     0.00     0.00
DEMAND-WEIGHTED AVERAGES:    5.75    55.00   187.00   489.00   659.00   961.72  1273.67     0.00     0.00     0.00
   OVERALL DEMAND-WEIGHTED AVERAGE:  1118.79
```